

**A MULTILEVEL ANALYSIS OF CHINA'S REGIONAL
INEQUALITY IN A GEOGRAPHIC INFORMATION
SYSTEM ENVIRONMENT**

by

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ABSTRACT

China's reform and transition have dramatically accelerated the socioeconomic development in the last three decades. At the same time, the unequal distributions of wealth and social resources have been intensified. China's regional inequality has attracted more attention from both policy makers and researchers. The central government has listed "reducing regional inequality" as one important goal of national development. This dissertation research intends to quantify China's regional development during the reform era by detecting the multiscale variation of regional inequality, examining the spatial-temporal hierarchy and influence of multimechanisms, and exploring one consequence of regional economic disparity.

First, this project investigates China's regional economic inequality from 1978 to 2007. I analyze the multiscalar spatial patterns of economic disparities with Coefficient of Variation (CV), Gini Coefficient, and Theil Index, and explore the spatial-temporal hierarchy of multimechanisms and their specific influences on regional economy through multilevel modeling. The results reveal the significant role of municipalities for shaping the spatial-temporal variation of China's economic development, and indicate the sensitivity of regional inequality to spatial scale. The analysis also illustrates that globalization has become the prominent mechanism of China's development in the recent decade.

Second, this study examines health care and health inequalities as an important consequence of an unbalanced regional economy. I apply Geographic Information System (GIS)-based spatial statistical methods such as Coefficient of Variation and Moran's I to detect spatial-temporal patterns of health care, and use multilevel regression to examine the linkages between health care, mortality, and regional economic inequality. The analysis reveals that health care inequality is also sensitive to geographic scale, and demonstrates that the concurrent transitions of decentralization, marketization, globalization, and urbanization in China have interactively contributed to health care inequality and mortality.

Third, this research conducts a case study in a less investigated agriculture-oriented interior province, Henan Province. Such statistical and GIS methods as CV, Getis-Ord G_i^* , and geographically weighted regression (GWR) are used to explore the disparities in economic development and health care level as well as to examine the effects of multiple transitions. The results uncover the significant core-periphery and urban-rural gaps in both economy and health care level.

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CHAPTER 1

INTRODUCTION

Background

Regional development is a hot area of academic research. Regional inequality is the most important of various regional development concerns as it reflects unequal opportunities among regions and may threaten national unity and social stability (Smith, 1995; Wei, 2000; World Bank, 1997). Traditionally, regional development refers to regional economic growth, and regional inequality means the economic disparities among regions. Regional inequality has become one of the research frontiers in the geography discipline due to the significance from both theory and policy perspectives. In recent years, the geographical aspect of development has become a mainstream concern, because differences in economic development are always associated with location (Krugman, 1999), and geographical scale is very important in regional inequality analysis (Wei, 1999, 2000, 2002).

China has been experiencing the multiple transitions of decentralization, marketization, globalization, and urbanization since the reform in 1978. The reform and transitions have boosted dramatic economic growth and social development in China (Li & Wei, 2010a). At the same time, the socioeconomic disparities have been exacerbated, which further cause a series of social problems, for example, frequent social conflicts,

difficult access to higher education and medical care, and the increasing urban poor. In order to reduce regional gaps, the central government has adjusted the regional strategies. Since the mid-1990s, the central government has listed “reducing regional disparity and promoting coordinated regional development” as one of the most important goals in Five-Year Plans. The “Western Development Program” (*xibu da kaifa*) and “Revive Northeastern Region” were proposed and launched to accelerate the economic development in the poor western region and in the northeastern, traditionally industrial provinces. Due to dramatic changes in the politics and economy of China, regional inequality has become a fertile research area. Some early literature observed a widening gap in regional development (e.g., Tsui, 1991), while recent scholars have investigated the mechanisms and attempted to theorize and understand the dynamic development (e.g., Wei & Ye, 2009). However, little is known about the spatial-temporal hierarchy of the mechanisms and the consequence of regional economic inequality.

This project aims to explore the regional inequality issue in China during the reform period from a geographical viewpoint. With the assistance of Geographic Information System (GIS) analytical tools and statistical techniques, the variations of regional inequalities in economic development and health are mapped and analyzed at the regional, provincial, and county scales. Different from previous single-level regression analysis of regional development, a multilevel model is applied to uncover the spatial-temporal hierarchy of multiple mechanism and to detect the specific influence of each mechanism on regional socioeconomic inequalities.

Literature Review and Research Objectives

Theoretical investigations of regional development

There have been theoretical debates on regional inequality since the 1950s. The main claim of convergence theories is that regional inequality will be minimized or possibly eliminated under conditions of free competition (Lipshitz, 1992). These conditions include free movement of production factors (labor and capital) and full access to information throughout regions. Contrary to the convergence school, the divergence theories insist that the spatial flow of production factors actually increases interregional gaps and regional inequality is inevitable under capitalism. This school of thoughts comprises two differing theories: the planned economics or government intervention theory and the radical theory. The former argues that government intervention tends to reduce the interregional disparities; the latter contends that the government's activities are liable to intensify regional inequality. Apart from the convergence and divergence schools, there are also other theories trying to generalize the patterns and mechanisms of regional development. For example, the growth pole theory (Perroux, 1955) points out that the locations where entrepreneurial innovation and “propulsive industries” are clustered serve as the engines for innovation and regional growth.

During the 1980s and early 1990s, a renewed discussion in regional inequality research emphasized the following five aspects: the migratory patterns in core and peripheral regions, the effects of globalization and liberalization, the reform and transition in former socialist countries, the rediscovery of regions and geography in social sciences, and new developments in the disciplines of economics and geography (Lipshitz

1992; Wei & Ye, 2009). Among the extensive literature, there are two influential theories: new convergence and new economic geography.

Barro and Sala-I-Martin (1991, 1992) have provided a new explanation on convergence which has become the most influential contemporary theory of regional inequality. Different from the previous σ -convergence concept, arguing that the dispersion of per capita income or outputs across regions declines over time, the new β -convergence, holds the tendency that poorer regions have to grow more rapidly than richer ones (Barro & Sala-i-Martin, 1991, 1992, 1995). The new convergence theory has fueled fresh debates and empirical testing, and has revitalized the study of regional inequality in mainstream economics (Wei & Ye, 2009). However, the new convergence theory also ignores space and time, which has seriously limited its applicability and power in interpretation.

Economists (Fujita & Krugman, 2004; Krugman, 1991; Krugman, 1995) have proposed new economic geography (NEG), and geographic (locational) factors have been emphasized by integrating traditional location theories and economic geography into this approach. Basically, NEG provides a model for understanding how the centripetal forces pull economic activity together and the centrifugal forces push it apart. The theory describes how the geographical structure of an economy is shaped by these two forces.

In summary, despite differences among the convergence school, the divergence school, and other theories, the above theories have common limitations. First, these theories do not take geographic scale into consideration. Both Western and Eastern scholars have demonstrated the importance of spatial scale on regional inequality. Dunford and Smith (2000) contend that “simultaneous and sequential falling behind

(divergence) is occurring as well as catching up (convergence).” They point out that Europe is producing complex and differentiated mosaics of uneven development with reduced inequality at some scales, and persistent or widening inequality at others scales. Wei (1999, 2000, 2002) also argued regional inequality is multiscalely layered in nature and sensitive to spatial scale in China. Second, these theories ignore the temporal process of development and the influence of cyclical effects on growth (Wei & Ye, 2009). Convergence or divergence trends depend on the initial levels of development and cycles of economic development, and therefore the choice of time period for study (Petrakos et al., 2005) and the level of economic development matter. Third, these theories are too insensitive to explain the complex transition in China. Wei (2002) reveals that regional inequality in China does not show clear either convergent or divergent patterns, and argues that it is influenced by multimechanisms. Due to the spatial hierarchal characteristics of regional inequality, these mechanisms also have their hierarchal structure (Li & Wei, 2010a). The above theories fail to recognize the hierarchies.

Policies and researches on China’s regional inequality

The above theories were developed primarily to explain regional development in Western capitalist countries. Therefore, none of them is capable of completely explaining the regional development in China due to the complex transition from a planned economy to a market economy and the unique historical and geographical factors. The rich and diverse literature on regional development in China is mingled with a multiplicity of theories, models, and schools of thought (Fan, 1997; Peng, 1991; Yang & Liang, 1994), which mainly stem from or are revisions of the above Western theories. These theories

attempt to explain regional inequalities within China in terms of the specific governmental policies that brought about China's unique economic development.

When the People's Republic of China was established in 1949, China faced chaos, severe depression, high inflation, and huge income and regional inequalities due to geophysical conditions as well as historical context. Because of the poor economy and serious regional imbalance, the Chinese government attempted to reduce regional inequality. Spatial equality, national defense, and economic efficiency were identified as the primary goals of the First Five-Year Plan (1953-57a) (Ma & Wei, 1997). In the early 1970s, the scholars of convergence and divergence debated over the impact of Mao's policy on regional inequality. Lardy (1975, 1978, 1980) argues that regional development converged during the Mao period, due primarily to the implementation of government policies. Other scholars believe that regional development has diverged during Mao's period because of Mao's policy of autarchy for certain regions, unfair price structure between raw materials and final products, as well as inefficient investment-return projects such as the "three frontiers construction" (Donnithorne, 1972, 1976; Kueh, 1989; Tsui, 1991; Wei, 2000).

Since 1978, China's dominant development policies have changed from self-reliance to open-door policies and policies of comparative advantages. Following the "ladder-step theory" (*tidu lilun*), the government encouraged coastal regions to "get rich quick." After a short period of stagnation following the Tiananmen incident in 1989, the government intended to transform China into a socialist market economy. During the 1990s, some coastal regions (Shanghai, Jiangsu, Guangdong, etc.) obtained rapid growth, while some interior areas were lagging far behind. Since the mid-1990s, the Chinese

government has made various efforts to alleviate regional inequality because economic polarization has threatened social and political stability. For example, in both the Ninth Five-Year Plan (1996-2000) and the Tenth Five-Year Plan (2001-2005), the government paid more attention to reduce poverty and to promote the balanced development between regions. The Eleventh Five-Year Plan (2006-2010) proposed the concept of a “harmonious socialist society” (*shehui zhuyi hexie shehui*), addressing regional inequality through the notion of “coordinated development between regions” (*qiyu xietiao fazhan*). Furthermore, the Chinese government has been more concerned with the development of other areas besides the coastal region. In 1999, the “Western Development Program” (*xibu da kaifa*) was launched to boost the economic development of 12 interior provinces in western China (Fan & Sun, 2008). In 2003, the premier, Jiabao Wen, first proposed “Revive Northeastern Region” (*zhenxing dongbei*) as a national policy (Xinhua Net, 2003). This policy provided financial, tax, public security, and social welfare advantages to three declining industrial provinces in the Northeastern region. Since 2004, government leaders have been advancing the concept of a Pan–Pearl River Delta region. This would extend economic benefits originally offered only to the Pearl River Delta Region to less developed provinces in southern and southwestern China (Fan & Sun, 2008; Yeung, 2005).

Due to the adjustment of China’s regional policies and the accessibility of finer scale data, along with development of GIS and spatial data analysis, scholars have been able to expand and deepen this research area. Since 2000, the research on the regional development in China has shown the following five new trends and characteristics.

First, some research has examined the efforts of the central government to develop interior China, for example, the “Western Development Program” (*xibu da kaifa*). Heilig (2006) pointed out that the provincial income differences in China resonate with those between developed and developing countries. Interprovincial inequality has also rebounded (Lu & Wang, 2002; Yu & Wei, 2003). However, Fan and Sun (2008) proposed the opposite argument that the Chinese government’s programs and efforts since the late 1990s to reduce regional inequality have had some initial success; interregional and intraregional inequalities first became stable and then declined.

Second, scholars have attempted to develop new explanations and propose new processes that are responsible for regional inequality (Cartier, 2001; Li & Wei, 2010a; Ma & Cui, 2002; Wei, 2000, 2002; Wei & Ye, 2004; Yu, 2006; Yu & Wei, 2003; Yu & Wei, 2008). Wei (2000, 2002) proposes multiscale and multimechanism concepts and argues that regional inequality in China is sensitive to geographical scale and is influenced by multiple mechanisms. China’s economic reforms and development can be better understood as a triple process of decentralization, marketization, and globalization. Other researchers have investigated the effects of fiscal decentralization (Kanbur & Zhang, 2005; Tsui & Wang, 2008), foreign investment (Fu, 2007; Kanbur & Zhang, 2005; Yu et al., 2011), policy bias (Ho & Li 2008; Lu & Wang, 2002), labor mobility (Chan & Wang, 2008; Ying, 2003), Human capital (Fleisher & Li, 2010), and globalization of science and technology (Liu et al., 2011; Segal, 2008; Sun & Wang, 2005).

Third, multiscale and finer scale analyses have been conducted to further aid in understanding China’s regional development. More recently, the research tends to focus

on analyzing inequality at the levels of counties, villages, households, and even individuals (Wan & Zhang, 2006). Some scholars (Wei et al., 2011; Wei & Ye, 2004; Wei & Ye, 2009; Ye & Wei, 2005; Yu & Wei, 2008; Zhang & Xu, 2011) examine the pattern of regional inequality in China at regional, interprovincial, and county levels. Others even explore this issue from a finer scale, for example, residential inequality among neighborhoods in Shanghai (Li & Wu, 2006), labor and capital inequality between and within villages (Zhou et al., 2008), and household income mobility (Ding, 2008). These analyses summarize that regional inequality is sensitive to geographic scales and spatial organization.

Fourth, specific aspects of social inequality have begun to attract attention to the process of regional development, for example, the inequality of health care, education, and gender. Some researchers have discussed increasing regional disparities in education and health status and explore the underlying factors, such as fiscal decentralization (UNDP, 2000; West & Wong, 1995), institutional and historic reasons (Li, 2006; Zhang & Kanbur, 2005) and rural-urban inequality (Qian & Smyth, 2008), and spatial segregation of minorities (Cao, 2008). Others have explored gender inequality on education opportunity (Dong et al., 2008), labor market (Shu, 2007), and occupation discrimination (Cai & Wu, 2006). Health and health care, in particular, has attracted extensive attention in the literature, which mainly involve these three aspects: (1) the unequal distribution of health care resources has been examined (Chou & Wang, 2009). (2) The inequality of individual health status has been studied, for example, mortality, life expectancy, and nutrition status (Glasser, 2006; Liu, 2008; Pei & Rodriguez, 2006; Zhao, 2006). (3) Some research (Cai, 2009; Lee, 2005; Li & Wei, 2010b) explores the factors

causing health inequality from the perspectives of economic reform, globalization, and informatization.

Finally, more vigorous methodological contributions have been obtained in this field. Geographers have used exploratory spatial data analysis (ESDA), visualization, spatial regression, and geographically weighted regression (GWR) and demonstrated that regional inequality in China is sensitive to geographical clustering and agglomeration (e.g., Huang & Leung, 2002; Wei, 2000; Ye & Wei, 2005; Ying, 2003; Yu & Wei, 2003; Yu & Wei, 2008). Yu (2006) and Yu and Wei (2008) further proposed spatial-temporal analysis based on spatial panel data, which better represented the dynamics of China's regional development from a methodological standpoint (Baltagi, 2005). More recently, some advanced spatial and statistical models have been applied to reveal China's development variation, for example, the vector-autoregressive (VAR) model (Chen, 2010) and the spatial Markov chain analysis (Wei et al., 2011).

Based on the above review, three areas deserve further research efforts. First, the scale nature of regional inequality and bottom-up forces can be studied further (Wei, 2007). Although there has been extensive research discussing the causes and mechanisms of the rising inequality in China, little is known about the relative importance of these contributing factors. Second, the research on the consequences of the rising inequality in China remains limited (Wan & Zhang, 2006), for example, the unevenness of the healthcare system. The inequality of health care has intensified, which merits more attention from geographers (Wei, 2007). There has been extensive research on unequal distribution of health care (Cai, 2009; Liu et al., 2008); however, little research focuses on the causal linkage between economic inequality and health care inequality. Thirdly,

the interior provinces have been rarely studied at the finer scale, and analysis and summary of their development characteristics are lacking.

Specifically, there are five research objectives in this proposed study: (1) To examine multiscale inequality, namely, regional-, provincial-, and county-levels. (2) The mechanisms behind the regional dynamics and their influence on inequality will be analyzed, such as globalization, decentralization, and marketization. (3) Inequality of health care will be examined as one of the consequences of economic inequality in this research. (4) An investigation on the interior province, Henan Province, will be conducted to reveal a different developing path from coastal regions. And finally, (5) multilevel modeling will be applied to detect the nonstationary relationship between development and mechanisms across space and time.

Following these research objectives, the primary research questions are proposed as: (1) Is the regional inequality in China sensitive to the geographical scales? (2) Do the mechanisms behind China's regional inequality have a spatial hierarchy? And how does the hierarchy influence the regional inequality patterns of China? (3) Does the health care system distributed unevenly? If so, does the regional economic inequality cause the health care system inequality?

Data and Methodology

Study area

The study area includes the 27 provinces and 4 municipalities of mainland China. These provinces are traditionally divided into three regions: eastern, central, and western. The eastern coastal region has benefitted from the preferential policies of the Chinese

government and from its greater accessibility to Chinese trading partners. The central interior region is the origin of China's culture, politics, and agricultural economy and therefore is highly populated. The less-developed western mountain region is sparsely populated but has rich natural resources. In order to keep the consistency of the study area, Chongqing is taken as a municipality in the whole study period though this city has been separated from Sichuan Province since 1997. Hainan is also considered as a province in this study though it was separated from Guangdong after 1988. Under the background of regional and provincial inequality, this study conducts a case study by investigating social and economic disparities among 108 counties and 51 subdistricts in Henan province from 1997 to 2008. The most important reasons for choosing Henan Province as a case study in this research are its special historical, geographic, social, and economic characteristics, as well as the lack of attention paid to it in the literature.

Data and data sources

Data acquired for this study include social economic data and GIS spatial files (shapefiles). Social economic data include the following 14 variables: constant GDP per capita (GDPPC); per capita fixed asset investment (FAIPC); share of state-owned enterprises in fixed-asset investment (SOE); institutions of higher education per 10,000 persons (EDU); foreign direct investment per capita (FDIPC); population density (POPDEN); percentage of migrants (MI); per capita fund for promoting technical innovation (INNO); per capita GDP generated by transportation, postal, and telecommunications (TRAN); coastal dummy (coastal province = 1; others = 0) (CD); western region dummy (western province = 1; others = 0) (WRD); population growth rate

in past year (POP). GIS shapefiles refer to boundary files of China and Henan Province. These data are from three sources: the first source is China data online (<http://chinadataonline.org>) which provides provincial social economic data and county-level health from 1978 to 2008. The second source is Henan statistical year books with county-level social economic data of Henan from 1997 to 2008. The third source is the China data center (<http://chinadatatcenter.org>) where GIS boundary files are downloaded.

Analysis methods

In order to explore the trend, mechanisms, and consequences of regional inequality in China during the economic reform period, statistical and GIS techniques are applied in this research.

Three statistical indices, CV, Gini coefficient, Theil index, are employed to examine the temporal variation of inequalities to minimize potential misinterpretation. The CV is a popular measure of statistical dispersion but it is sensitive to outliers. The Gini coefficient is based on the Lorenz curve, graphically representing the cumulative distribution function of a probability distribution, which is strongly affected by high values. The Theil index is a measure of information entropy; however, it is sensitive to low incomes (Fan & Sun, 2008; Li & Wei, 2010a; Shorrocks, 2006).

The above three inequality measures only reveal overall inequality, but have limited utility in displaying spatial agglomeration (Yu & Wei, 2003). Moran's I was commonly used to analyze spatial autocorrelation and spatial relationships among provinces, which could uncover further provincial inequality in China. The Global Moran's I (Anselin, 1995) is used as a measure of the overall clustering. And the Local

Moran's I, the so called Local Indicators of Spatial Association (LISA; Anselin, 1995), is applied to examine the association for each unit and identify the type of spatial correlation. Getis-Ord G_i^* is employed to reveal the spatial clusters of economic development as well as health care level in Henan Province. This statistic, developed by Getis and Ord (1992), measures the spatial concentration of features with high values or low values based on the weighted points.

The mechanism behind the changing regional inequality is further analyzed through the geographically weighted regression model (GWR) and multilevel modeling. GWR is a newly developed technique to explore social processes and has been applied in regional inequality research. Unlike physical processes, social processes appear to be *nonstationary*, which means the measurement of a relationship depends partially on where the measurement is taken. However, studies on development mechanisms follow a traditional stationary and nonspatial route (Barro & Sala-I-Martin, 1995; Wei, 2000; Wei & Fan, 2000; Wei & Kim, 2002; Yu & Wei, 2003) which assumes the relationship under study is constant over space, and therefore, this technique is unable to efficiently explain the spatial variation of regional inequality. Geographically weighted regression (GWR) has been developed and updated (Fotheringham et al., 2001, 2002; Fotheringham & Zhan, 1996; Openshaw et al., 1987) to deal with the nonstationary data by allowing regression model parameters to change over space. GWR extends the traditional regression framework by incorporating the local spatial relationship and calibrating models locally across the study area.

GWR has solved the challenge of studying the nonstationary process of regional inequality; however, the single-level regression techniques treat the units of analysis as

independent observations and fail to recognize hierarchical structures. The consequence is that standard errors of regression coefficients will be underestimated, leading to an overstatement of statistical significance. Multilevel modeling has overcome the limitation which recognizes the existence of data hierarchies by allowing for residual components at each level in the hierarchy. The application of the multilevel modeling to regional inequality is very limited. Previous research does not distinguish the factors at different spatial levels and is unable to identify their relative importance to the regional inequality. The application of multilevel modeling attempts to separate the effects of provincial, regional, and time characteristics (contextual effects) on China's regional inequality.

This research intends to examine China's regional inequality at different spatial scales in light of the complexities of the economic, historical, geographic, and political-economic context. With the assistance of Geographic Information System (GIS) analytical tools and techniques, the geographic patterns of regional inequality will be mapped and analyzed. Different from previous single model analyses of regional development, a multilevel model that deals with interregional and provincial inequality at different levels will be applied to uncover development trends and to detect the influence of various factors or independent variables on regional inequalities in China. The independent variables will be categorized as regional or provincial and weighted based on their characteristics and influences. Variables with common features within a region will be classified into an interregional level; those with unique provincial features will be grouped into an interprovincial level. Therefore, the application of multilevel modeling will overcome both theoretical and methodological limitations of the previous research.

Organization of the Dissertation

This research is organized into five chapters. Following this introductory chapter, Chapter 2 advances the multiscale and multimechanism framework of regional inequality in China by using the most recent statistical data. Choosing constant GPD per capita as the indicator of regional development, this chapter analyzes the multiscale patterns of China's regional economic inequality with GIS and statistical techniques, and highlights the significance of the municipality effect. Multilevel modeling is used to examine the spatial-temporal hierarchy of multimechanisms and reveal the relative influence of globalization, marketization, and decentralization.

Chapter 3 explores health and health care unevenness, as one consequence of China's regional economic inequality. This chapter examines spatial-temporal variations of health care inequality at the regional, provincial, and county levels; analyzes whether economic growth and transition to a market economy have exacerbated the unevenness of health care; and then reveals the impact of health care inequality on health outcomes, especially mortality. GIS-based spatial statistical methods are applied to detect spatial-temporal patterns of health care; and to examine the linkages between health care, mortality, and regional economic inequality; and ultimately to assess the sensitivity of health care inequality to geographic scale and evaluate whether reforms implemented to date have provided more equitable access to health care.

Chapter 4 turns to a case study and investigates the core-periphery and urban-rural disparities in both economic development and health care in an agriculture-oriented China's province, Henan Province. Such methods as CV and Getis-Ord G_i^* are applied

to detect the spatial-temporal variation of social economic unevenness at both county- and prefecture-levels. GWR is employed to analyze the underlying driving forces.

Chapter 5 discusses and concludes the major findings presented in the previous chapters, and highlights the directions of future studies.

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CHAPTER 2

SPATIAL-TEMPORAL HIERARCHY OF REGIONAL ECONOMIC INEQUALITY OF CHINA^{1 2}

Abstract

This paper advances the multiscale and multimechanism framework of regional inequality in China by using the most recent statistical data. We analyze the multiscalar patterns of China's regional inequality with GIS and statistical techniques, and demonstrate the significance of the municipality effect. The authors also apply multilevel modeling to identify the spatial structure and time dimension of the underlying forces driving regional development. This study illustrates that China's regional inequality is sensitive to the spatial-temporal hierarchy of multimechanisms, and reveals the relative influence of globalization, marketization, and decentralization.

Introduction

China has been experiencing a gradual transition from a command economy to a market economy, and has achieved tremendous economic growth in the last three decades.

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² Li, Y. & Wei, Y.H.D. (2010). The spatial-temporal hierarchy of regional inequality of China. *Applied Geography*, 30, 303–316.

At the same time, the uneven process of economic development among regions has also been intensified. Regional inequality has become a serious issue attracting considerable attention from both the government and researchers.

Regional inequality is an important issue of government policies (Wei, 2002). The Chinese government's regional policies and strategies have been changing in order to effect economic transition and social development. Since the government launched the open-door policy in 1978, China has maintained a comparative advantage and an open-door policy that focus on growth of the coastal regions to attract foreign investment and stimulate economic growth. To further the economic reform, in 1992, Deng Xiaoping, the leader of China, proposed "socialist marketization" and advocated establishing various types of enterprises besides state-owned enterprises. In the last decade, due to the increasing economic gap among regions, the Chinese government has paid more attention to solving economic polarization and endorsing programs to alleviate inequality. For example, in 1999, the "Western Development Program" (*xibu da kaifa*) was launched to boost the economic development of 12 provincial-level units (hereafter provinces) in the poorer western region. In 2003, Premier Wen Jiabao proposed "Reviving Northeastern Region" (*zhenxing dongbei*) as a national policy. The pattern of regional inequalities in China has been changing with these policies at different periods. Therefore, it is necessary to examine the time dimension for analyzing China's regional inequality.

Regional inequality has always been a hot research area of geographers and economists. In recent years, the geographical aspect of development has become a mainstream concern, because differences in economic development are always associated with location (Krugman, 1999); the geographical scale is very important in regional

inequality analysis (Wei, 2002; Wei & Fan, 2000; Wei & Ye, 2009). Some scholars have investigated the spatial patterns of China's economic development (e.g., Fan & Sun, 2008; Wei, 1998, 2002; Yu & Wei, 2003) and attempted to develop new explanations for regional inequality by studying spatial autocorrelation (e.g., Wei & Ye, 2004; Yu, 2006; Yu & Wei, 2008). However, the spatial-temporal hierarchy of regional inequality has been rarely studied, and the relevant importance of the factors underlying regional inequality is still unclear.

This paper analyzes the evolving patterns of regional inequality in China from 1978 to 2007, with an emphasis on the hierarchy of underlying factors and the time dimension with multilevel modeling. The next section outlines the literature and analytic framework of this research, followed by a discussion of data and methodology. Then, we examine the pattern and the spatial hierarchy of China's regional inequality. Finally, we conclude with major findings.

Literature Review and Analytic Framework

Theories of regional inequality are mainly dealing with three problems: the question whether regional equality increases or decreases over time, the causes of inequality, and the development strategy for reducing regional inequality (Lipshitz, 1992). Since the 1950s, there has been a heated debate between the convergence and divergence schools. The neoclassical theory and inverted-U models are widely known representations of the convergence school of thought. The neoclassical growth theory emphasizes equilibrium conditions and the importance of the market in allocating resources, and considers regional inequality as a transitory phenomenon and an inevitable

stage for the final equilibrium. Similarly, the inverted-U theory maintains that regional inequality increases during the early stages of development and decreases as the economy matures (Alonso, 1980; Friedmann, 1966; Hirschman, 1958; Williamson, 1965). Scholars such as Perroux and Hirschman advocate government intervention and promote the development of growth poles. This idea is also known as top-down development, or development from above (Wei & Ye, 2009). However, the persistence of poverty and regional inequality in the 1970s prompted the development of alternative schools emphasizing divergence and cumulative causation. The radical political economy perspective, for example, views regional inequality as inevitable under a capitalist system (Smith, 1984), which is pessimistic about the policy effects of regional inequality.

During the 1990s, Barro and Sala-I-Martin (1991, 1992) provided a new explanation of convergence which has renewed the discussion on regional inequality. The β -convergence indicates the trend that poorer regions grow more rapidly than wealthier regions, while the absolute difference may not necessarily decline over a period of time. Such a neoclassical approach emphasizing convergence has once again been criticized and challenged (e.g., Silva, 2007; Venables, 2005). Krugman's (1991) new economic geography, for example, emphasizes geographic (locational) factors and integrates traditional location theories and economic geography into this approach. However, these theories de-emphasize such important factors as institutional effect, spatial scale, spatial hierarchy, and the time dimension (Wei & Ye, 2009). These theories were also developed primarily to explain regional development in Western capitalist countries. Though these theories have influenced the policies and research on China's regional inequality, they

have limited power in explaining regional inequality in China, which is under the transition to a socialist market economy.

Stemming from the above Western theories, the literature on China's regional inequality has displayed its own characteristics and proposed some new analytical frameworks (e.g., Wei, 2002; Wei & Ye, 2009; Yang & Liang, 1994). First, scholars have developed new explanations and proposed new processes that are responsible for regional inequality. Wei (2002, 1999) proposed the multiscale and multimechanism frameworks and argued that China's economic reform can be better understood as a triple process of decentralization, marketization, and globalization; and regional inequality in China is sensitive to geographical scale and is influenced by multiple mechanisms. Researchers have investigated the effects of fiscal decentralization (e.g., Kanbur & Zhang, 2005; Tsui & Wang, 2008; Wei, 1996), foreign investment (e.g., Fu, 2007; Kanbur & Zhang, 2005), policy bias (e.g., Ho & Li, 2008; Lu & Wang, 2002), labor mobility (e.g., Ying, 2003), and globalization of science and technology (e.g., Lu & Wei, 2007; Segal, 2008; Sun & Wang, 2005). Second, some research has examined the efforts of the central government to develop interior China. For example, Fan and Sun (2008) presented an opposing argument that the Chinese government's programs and efforts since the late 1990s to reduce regional inequality have had some initial success; interregional and intraregional inequalities first became stable and then declined. Third, more vigorous methodological contributions have been produced in this field. Using visualization, spatial regression, and geographically weighted regression (GWR), geographers, Wei and his associates in particular, have demonstrated that regional inequality in China is sensitive to geographical clustering and agglomeration (e.g., Wei & Ye, 2009; Ye & Wei, 2005; Ying,

2003; Yu & Wei, 2003, 2008). Yu (2006) and Yu and Wei (2008) further presented spatial-temporal analysis based on spatial panel data, which better represented the dynamics of China's regional development.

The above theories and methodologies have been widely utilized in various study cases to highlight policy implications of regional development. For example, Jones and Wild (1997) examine the regional differentiation and spatial variability of Germany with GIS, and recognize the regional polarities between agglomeration cores and rural residuals after the unification of East Germany and West Germany in 1990. Their empirical results indicate the importance of reconstructing the economic culture of eastern Germany and incorporating subregional differentiation into a new framework of regional policy. Yao and Zhang (2001) propose a production model based on an augmented Solow growth model, and show that the regional economy in contemporary China has become more divergent in the reform period. They suggest that the current policies focusing on the western region cannot effectively boost economic development in the remote western provinces due to the distance effects and adverse production environment. More recently, scholars have further explored the impacts of regional differentiation on sustainable development in England with GIS spatial analysis (Hube, Owen, & Cinderby, 2007) and in Massachusetts, USA with GWR (Ogneva-Himmelberger, Pearsall, & Rakshit, 2009). They argue that because of the interactive relationship between socioeconomic inequality and environmental protection, the relevant policy intervention would be better developed by considering both socioeconomic and environmental conditions.

Based on the above review, three areas deserve more research efforts. First, the scale nature of regional inequality should be further studied (Wei, 2007; Wei & Ye, 2009). Although there has been extensive research on the causes and mechanisms of the rising inequality in China, little is known about the relative importance of these contributing factors. Second, the spatial hierarchy of regional inequality has not been thoroughly examined, and a single-level investigation might hide some important characteristics of regional inequality. The application of the multilevel modeling in regional inequality is very limited. Third, government policies keep changing in the reform era, and consequently, the influence of the time dimension on regional inequality should be examined. The objectives of this research are to map the shifts in patterns of regional inequality at different geographic scales in China since 1978, to explore the spatial hierarchy of the mechanisms, and to examine the influence of underlining factors.

This paper maintains that regional inequality in China is sensitive to spatial scale, and that multimechanisms of regional inequality have a spatial-temporal hierarchical structure, which influences the patterns of regional inequality. This research is conducted under the framework of multiscale, multilevel, and multimechanisms.

Multiscale

There are 31 provincial administrative units (hereafter provinces) in China. These provinces are traditionally grouped into three regions: eastern, central, and western (Fig. 2.1). The “three economic belts” scheme is based on the Seventh Five-Year Plan (1986–1990) and is commonly used to analyze regional inequality in China (e.g., Fan & Sun, 2008; Lee, 2000; Wei, 2002; Yu & Wei, 2003). The eastern coastal region has benefitted

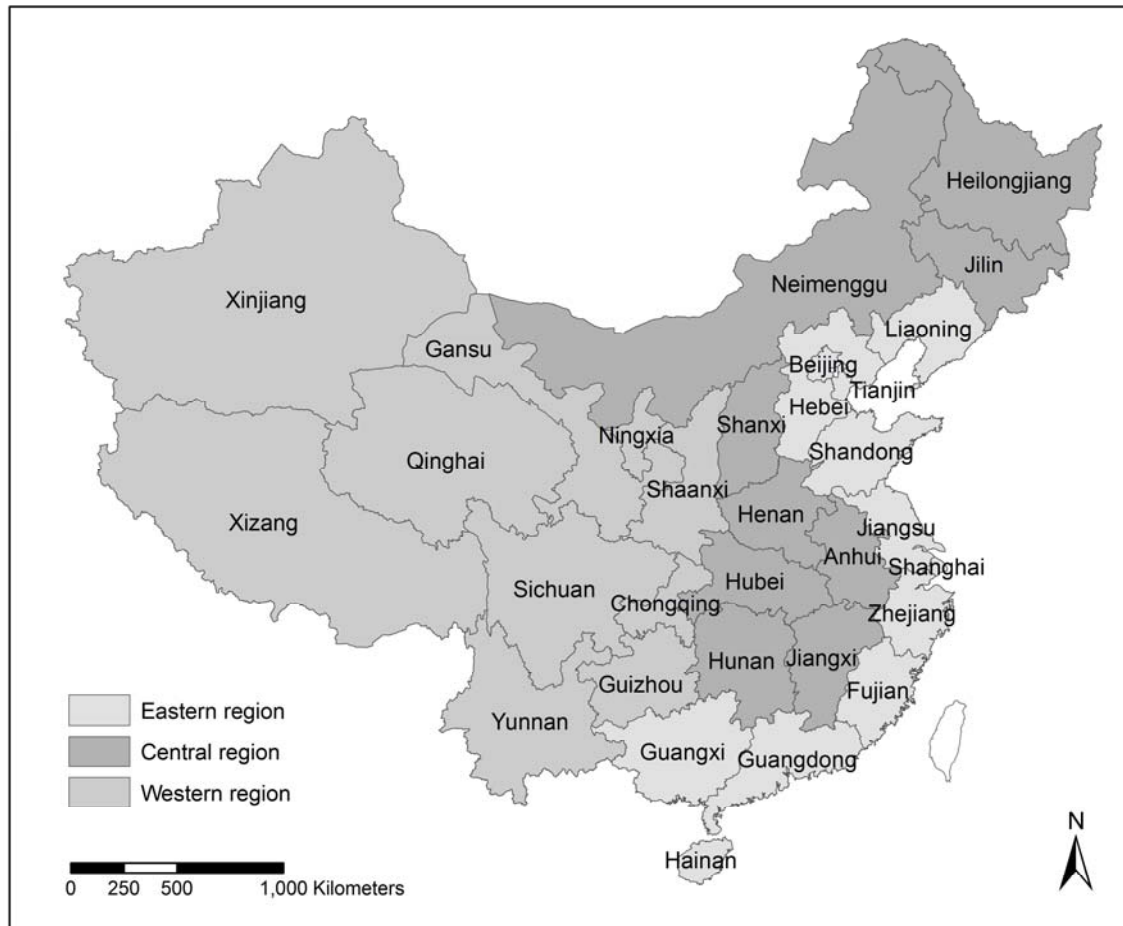


Figure 2. 1 Three regions and provincial-level units in China.

from the preferential policies of the Chinese government and from its greater accessibility to foreign trading partners. The central interior region is the origin of China's culture, politics, and agricultural economy, and, therefore, is highly populated. The less-developed western mountain region is sparsely populated but has rich natural resources. This research examines the patterns of regional inequality at three different geographic scales: interprovince, between all provinces; interregion, between the three regions; and intraregion, between the provinces of each region.

Multimechanism

China's economic growth can be described by the triple transitions of decentralization, marketization, and globalization, which have introduced a new set of institutional and market forces (Wei, 1999; Wei & Fan, 2000) (Fig. 2.2). He, Wei, and Xie (2008) have further defined these transitions and analyzed their effects on geographical concentration. Regional decentralization from the central to local governments reflects the institutional change, not only triggering interregional competition for business, but also pushing local governments to implement successful development policies (Montinola, Qian, & Weingast, 1995). Conversely, marketization and globalization create the conditions of comparative advantage and agglomeration economies. The economic reform has stimulated foreign investment and exports; however, the preferential policies are unevenly practiced in some selected areas, especially the coastal region. Therefore, the market force has changed the dominant role of state-owned enterprises, and advocated the competition between firms with various ownership forms, for example, joint-venture enterprises. The globalization process has

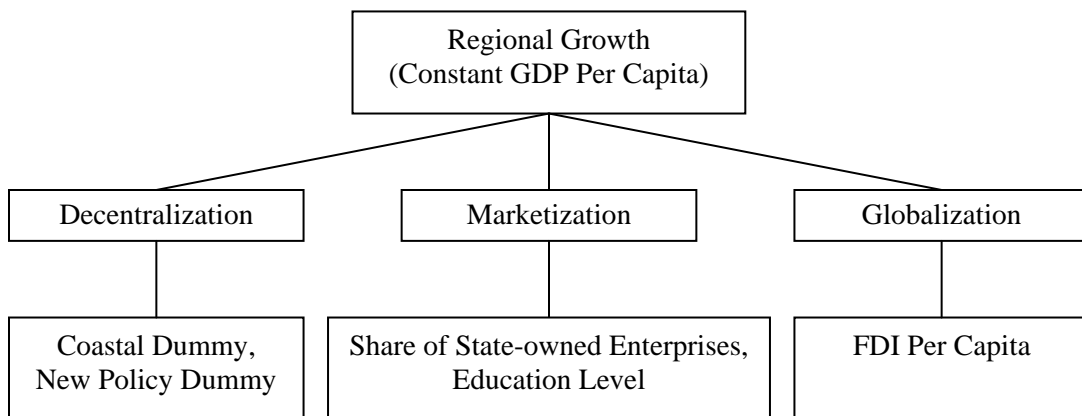


Figure 2. 2 Multimechanisms of China's regional development.

enhanced the comparative advantage due to geographical concentration. This research chooses specific indicators for each transition, which will be discussed in detail later.

Multilevel

Each of the three economic belts in China has unique geographical, historical, economic, and cultural characteristics. China's administrative divisions and policy-making have a spatial hierarchical structure. The economic policies have been conveyed through multiple levels of government, including province, prefecture-level city, county, township, and village. The current literature has not effectively identified the spatial hierarchy of both economic growth and the underlying mechanisms, and, therefore, is unable to capture the relative importance of these mechanisms, including the characteristics of regional inequality. This research explains the process of economic growth at three levels (Fig. 2.3). Due to the change of China's economic policies after reform, and the important role of regional inequality, the time level is selected as the first

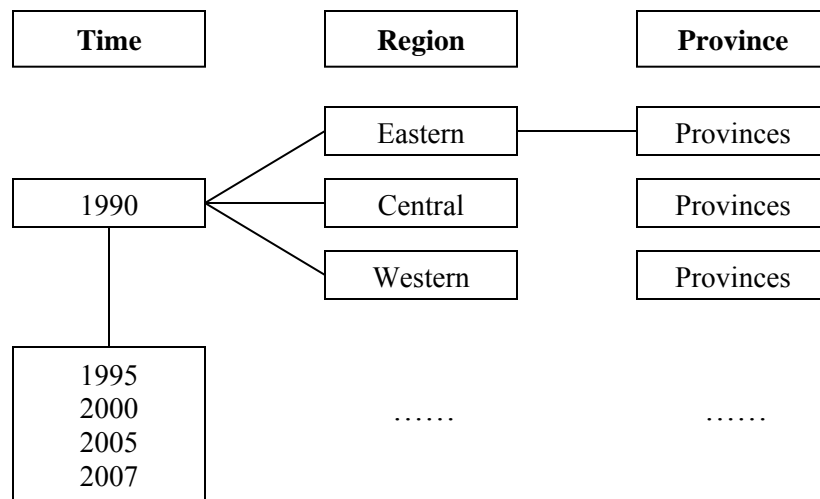


Figure 2. 3 Multilevel framework of China's regional development.

level. There is no regional government established for the coastal, central, and western regions, but different economic policies have been carried out in these regions due to their variety in policy, geography, and history. Therefore, the regional level is the second level. Province level, the third level, is identified to examine the uniqueness of each province.

Data and Methodology

Study area

The study area includes the 27 provinces and 4 municipalities of mainland China. In order to keep the consistency of the study area, Chongqing is taken as a provincial-level municipality, although this city has been separated from Sichuan Province since 1997. Hainan, separated from Guangdong Province after 1988, is also considered as a province in this study. The municipalities are special province-level subdivisions, which are not restricted to the multilevel administration system (Song, 1999) and benefit from similar or even more preferential policies than other coastal provinces (Wu, 2005). Therefore, they can obtain more funding and projects from the central government and have more opportunities to attract foreign investment. The eastern region has three municipalities: Beijing, Shanghai, and Tianjin; the western region has one municipality, Chongqing.

Data

Data for this study include constant GDP per capita (GDPPC), per capita foreign direct investment (FDIPC), the share of state-owned enterprises (SOE), education (EDU),

population growth rate (POPGR), and GIS shapefile. These social and economic data are obtained mainly from China data online (<http://chinadataonline.org>). The constant GDP per capita are chosen as the indicator of the overall level of economic development, which is most commonly used (Fan & Sun, 2008). We apply the provincial indices to convert GDP per capita in current prices into 1978 constant prices. GIS shapefiles are downloaded from the China Data Center (<http://chinadatatcenter.org>)

Methods

This research explores the interregional, interprovincial, and intraregional inequality of China with three statistical indices. The coefficient of variation (CV), Gini coefficient, and Theil index are commonly employed in measuring regional inequality. The CV is a popular measure of statistical dispersion, defined as the ratio of the standard deviation to the mean. The Gini coefficient is based on the Lorenz curve, graphically representing the cumulative distribution function of a probability distribution. The Theil index is a measure of information entropy. However, the CV is sensitive to outliers, the Gini coefficient is highly affected by high values, and the Theil index is sensitive to low incomes (Fan & Sun, 2008; Shorrocks, 2006). Thus we use all of the three measures and compare the results in order to minimize the possible misinterpretation and provide a credible explanation.

To further understand China's regional inequality, multilevel regression modeling is applied to examine the underlining mechanisms. The existing literature commonly uses the single-level regression technique, which treats the units of analysis as independent observations, and fails to recognize hierarchical structures. The consequence is that

standard errors of regression coefficients would be underestimated, leading to an overstatement of statistical significance. Multilevel modeling overcomes that limitation and recognizes the existence of data hierarchies by allowing for residual components at each level in the hierarchy. The spatial application of multilevel modeling attempts to separate the effects of personal characteristics and place characteristics (contextual effects) on behavior (Duncan & Jones, 2000; Fotheringham et al., 2002; Goldstein, 1987). The multilevel regression analysis is conducted in MLwiN 2.02 (Rasbash et al., 2005) to fit these three models.

$$y_{ijt} = \beta_0 + \beta_1 x_{ijt} + u_t + r_{jt} + e_{ijt}$$

where, y_{ijt} is the dependent variable in region j at year t ; x_{ijt} is the independent variables in region j at year t ; u_t is the standard error at year t ; r_{jt} is the standard error of region j at year t ; e_{ijt} is the standard error of i in region j at year t .

This research runs single-level (province), two-level (region and province), and three-level (time, region, and province) regression models to identify personal effect, contextual effect, as well as time effect. Five time points, 1990, 1995, 2000, 2005, and 2007 are included. The dependent variable is the constant GDP per capita (GDPPC). Following the rationale in Yu and Wei's paper (2003), this research chooses the following six independent variables:

(1) The foreign direct investment per capita (FDIPC) reflects the effect of globalization. The more globalized the region is, the more FDI the region has obtained. We expect a positive relationship between FDIPC and economic growth.

(2) The share of state-owned enterprises in a province's fixed asset investment (SOE) is an indicator of marketization. A higher SOE reflects lower level of marketization. The SOE is expected to negatively affect economic growth.

(3) The education level (EDU) is the number of institutions of higher education per 10,000 persons, which represents labor quality, and is also an indicator of marketization. We expect a positive relationship with economic growth.

(4) The population growth rate (POPGR) is a control variable. For 1990, 1995, 2000, and 2005 POPGR, the population growth rate in the last five years are calculated. For 2007 POPGR, the population growth rate from 2005 to 2007 is computed. A negative relationship with economic growth is expected.

(5) The coastal dummy (CDummy) is a locational factor that mainly shows the level of decentralization, since the central government has opened coastal provinces first and allowed them more decision-making power. The coastal province is 1, and noncoastal province is 0. We expect the positive relationship between the CDummy and economic growth.

(6) The new policy dummy (NPDummy) is a newly proposed variable, used to examine whether the new policies have stimulated development in the western region as well as the northeastern region, and have effectively reduced the regional inequality. The province under "Western Development Program" and "Reviving Northeastern Region" are defined as 1, other provinces 0. The first five independent variables follow the research of Yu and Wei (2003). A positive relationship is expected.

(7) The per capita fixed asset investment (FAIPC) is also selected as a control variable since it has been a major factor of economic growth in China (Wei & Kim, 2002; Yu & Wei, 2008). We expect a positive relationship between FAIPC and GDPPC.

Migration is not taken as an independent variable in this paper, although it has been an important issue of China's regional development. Migration in China has been considered largely a consequence rather than a driving force of regional inequality, in response especially to regional disparity in job growth. Wei (1997) has found that state policy, global forces, and regional disparities have all determined the migration pattern of China. Fan (2005) has also emphasized the increasing influence of regional inequality on migration trend in China.

Findings and Interpretation

Regional inequality trends and the role of municipalities

The CV, Gini, and Theil all reveal similar results of the regional inequality of China in the period from 1978 to 2007 (Figs. 2.4 and 2.5). The interprovincial inequality basically showed a U-shaped pattern before 1999 which has been proved by several previous researches (e.g., Lu & Wang, 2002; Yu & Wei, 2003). Since 2000, the interprovincial inequality fluctuated significantly: a sharp decline in 1999 and 2000, an increase from 2001 to 2004, and a 3-year consecutive decline from 2005 to 2007. However, the interregional inequality had a different trajectory. It showed a ladder-like upward trend and increased gradually. Based on the coefficient of variation, the Gini coefficient, and the Theil index, the interprovincial inequality in 2007 was 20%, 1%, and 5% lower than the 1978 level, respectively; while the interregional inequality in 2007 was

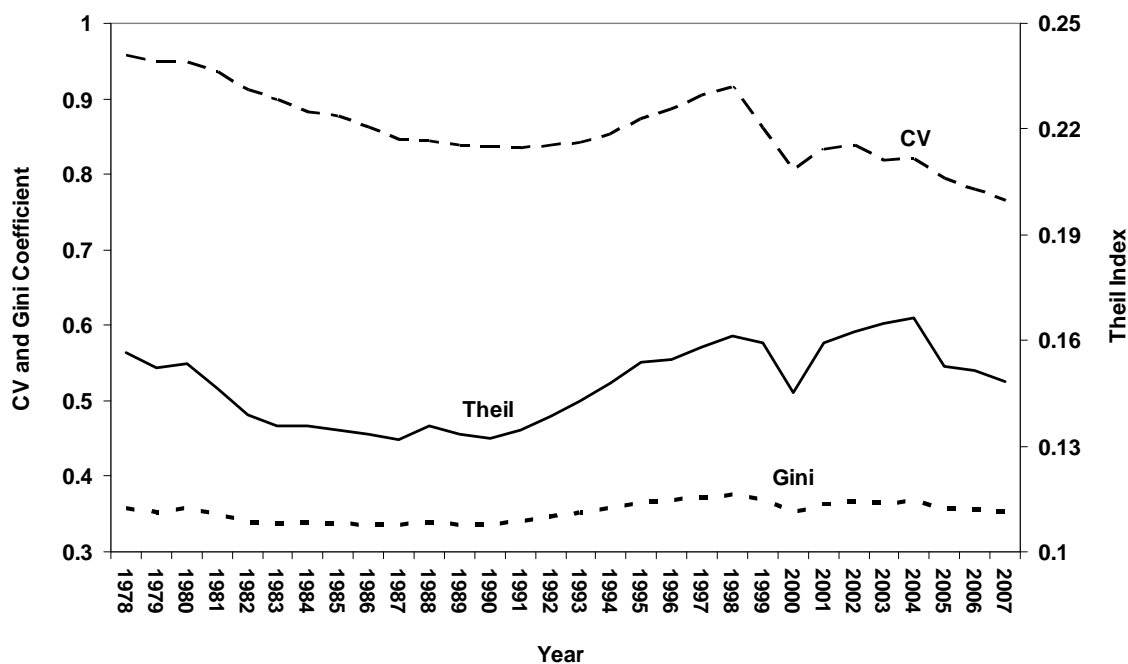


Figure 2. 4 Interprovincial inequality of GDP per capita in China, 1978-2007.

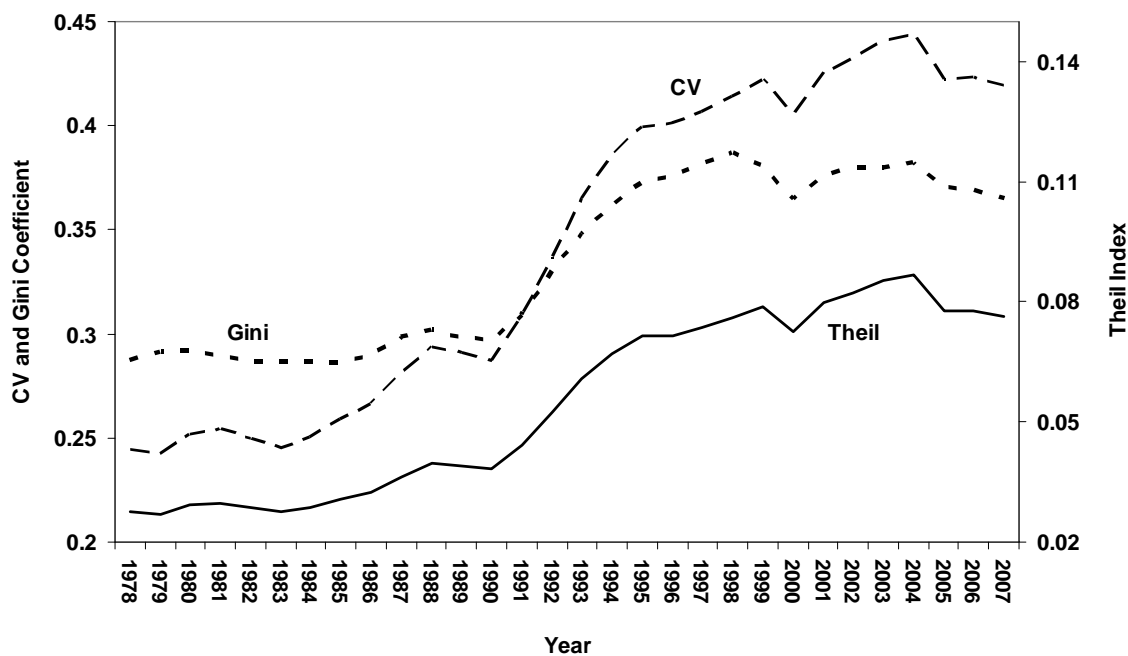


Figure 2. 5 Interregional inequality of GDP per capita in China, 1978-2007.

71%, 27%, and 175% higher than the 1978 inequality (Table 2.1). Therefore, China's regional inequality does not follow either convergence or divergence schools of thought and appeared to have more complex patterns than what these western theories interpret.

Though interprovincial and interregional inequalities have different trends, both are responding to the changes of economic policies. The economic reform launched in 1978 stimulated the development of some coastal provinces, which lagged behind previously. Therefore, the interprovincial inequality in the 1980s decreased. However, these policies did not close the gap between the three regions, and thus the regional inequality in this period still increased. Deng Xiaoping's Southern Tour in 1992 pushed the open-door policy forward and further accelerated the growth of the coastal region and made it much richer than interior regions, causing both interprovincial and interregional inequality to increase in the 1990s. Since the late 1990s, China has carried on a series of policies and strategies for alleviating regional inequality. For example, the Ninth Five-Year Plan (1996–2000) and the Tenth Five-Year Plan (2001–2005) proposed to promote the balanced development between regions. Both interprovincial and interregional inequalities have noticeable drops at the end of the 1990s, but they had up-down fluctuations after 2000. We need a longer period to examine whether these new policies

Table 2. 1 Coefficient of variation (CV), Gini coefficient, and Theil index of the constant GDP per capita of China.

Measure	Interprovince				Interregion			
	1978	1990	2000	2007	1978	1990	2000	2007
CV	0.96	0.84	0.81	0.76	0.24	0.29	0.41	0.42
Gini	0.36	0.33	0.35	0.35	0.29	0.30	0.37	0.37
Theil	0.16	0.13	0.15	0.15	0.03	0.04	0.07	0.08

Source: China data online.

and strategies have a long-lasting effect on reducing regional inequality because the short-term decrease might only be a period of fluctuation. Ho and Li (2008) did not find any evidence for the effectiveness of these new policies based on the analysis from 1952 to 2000. However, Fan and Sun (2008) highlighted the initial success on reducing the regional inequality according to the declined inequality from 2004 to 2006. This research holds that China's severe unequal economic development is caused by the policies as well as the initial conditions. However, the empirical analyses demonstrate that the efforts made by the Chinese government only have a certain amount of influence on regional development, but have not fundamentally solved the inequality issue.

It is worthwhile to point out that the municipalities have fundamental influences on the overall regional inequality of China. We have calculated the CVs of the constant GDP per capita of interprovince, interregion, and intraregion with and without the four municipalities (Figs. 2.6 and 2.7). The CVs of interprovincial inequality vary from 0.76 to 0.96, while those of interregional inequality range from 0.24 to 0.44 and show quite different patterns (Fig. 2.6). After removing the four municipalities of Beijing, Shanghai, Tianjin, and Chongqing, both interprovincial and interregional inequalities dropped down significantly. The former changed from 0.27 to 0.46, and the latter from 0.07 to 0.33. The lines of interregional, interprovincial, and interregional inequality without municipalities had very similar trends. Apparently, the advanced municipalities are a notable component causing the substantial inequality among regions. In addition, the municipalities also have an effect on uneven development within regions. Fig. 2.7 highlights the changes of the intraregional inequality of the constant GDP per capita from 1978 to 2007. The eastern region experienced much more uneven development than the central and western regions,

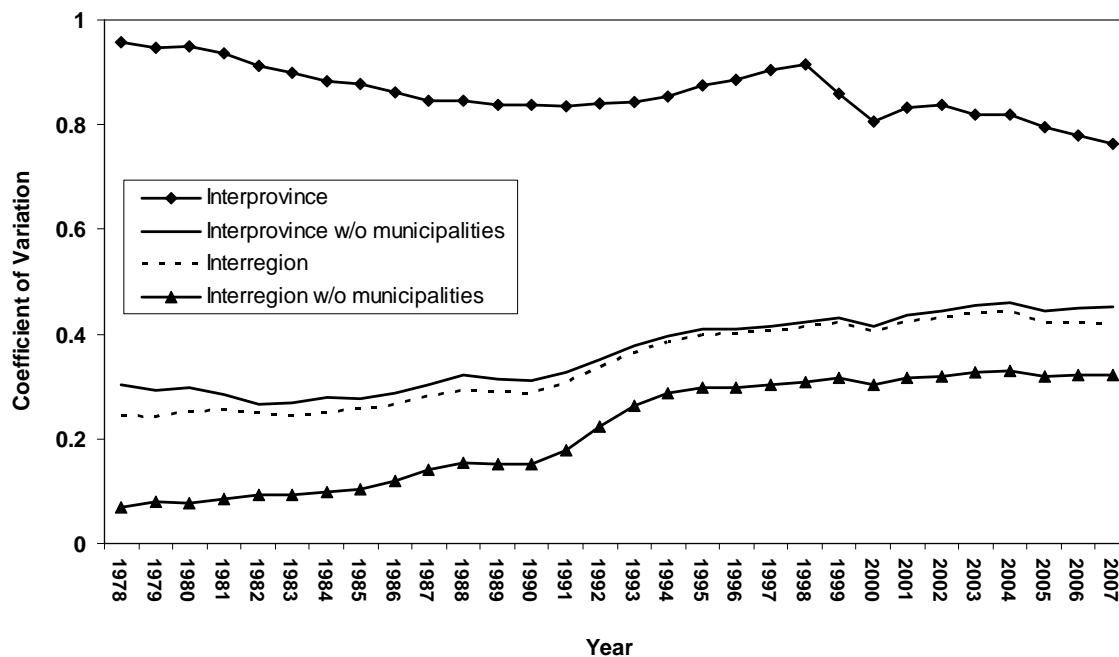


Figure 2. 6 Inequalities of interregion and interprovince in China, 1978-2007.

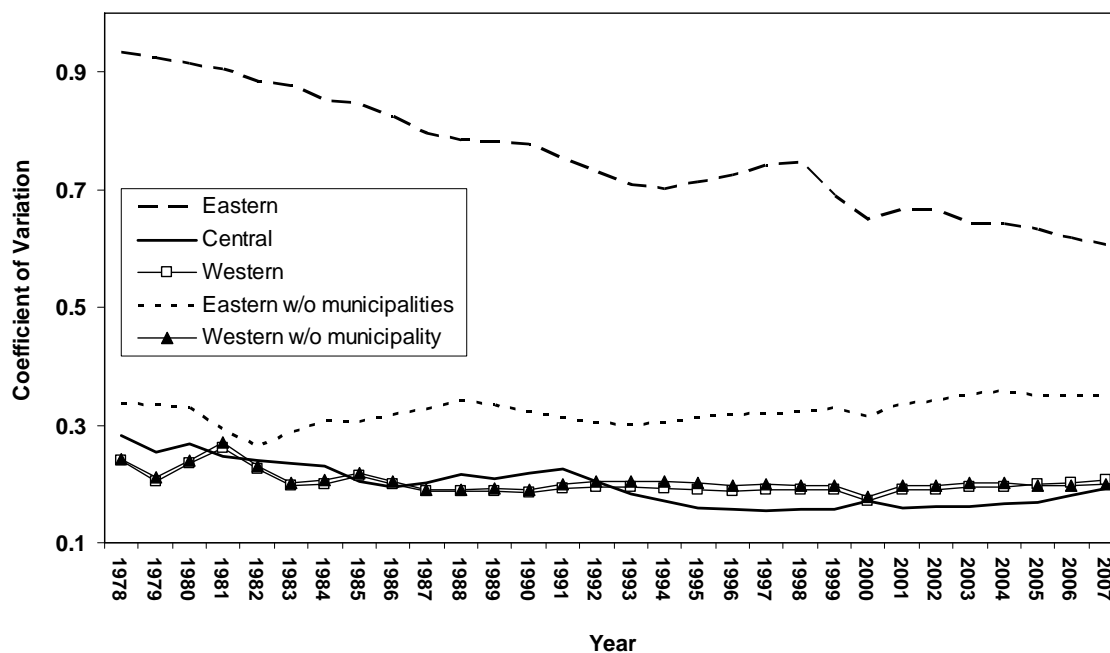


Figure 2. 7 Inequality of intraregion in China, 1978-2007.

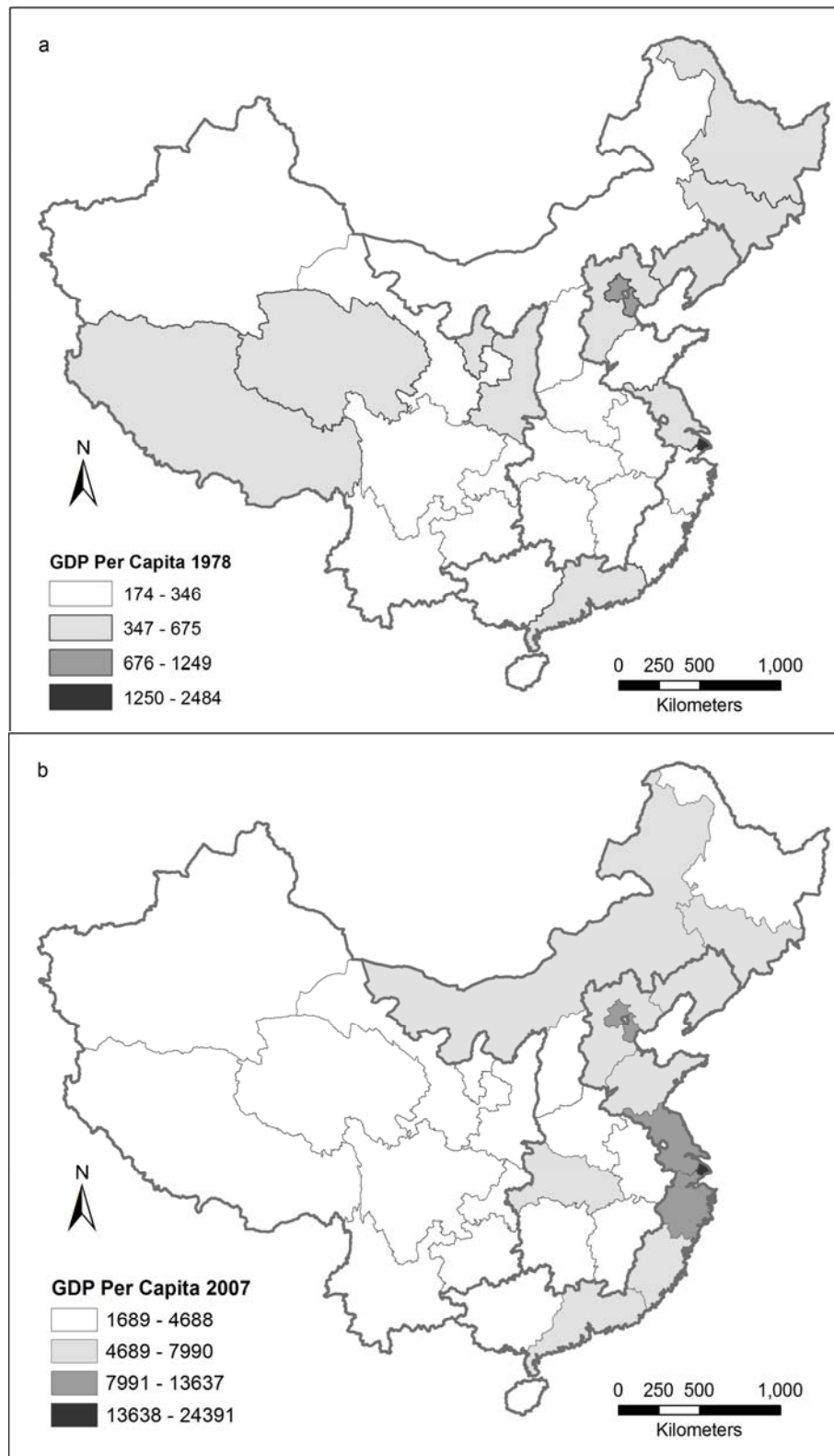
but showed a clear downward pattern. The CVs decreased from 0.93 in 1978 to 0.61 in 2007. The central and western regions remained relatively stable among provinces, and neither of them has significant up or down changes. Without Beijing, Tianjin, and Shanghai, the CVs of the eastern region decreased sharply and changed from 0.26 to 0.36, because other coastal provinces were in similar levels of economic development (Table 2.2). These three municipalities caused the serious inequality within the eastern region. In contrast, Chongqing's role in the western region was still limited because it has been upgraded to a municipality for only one decade. Its economic development lagged far behind the other three municipalities and is not significantly different from other western provinces (Table 2.2). However, the promotion as a municipality in 1997 has dramatically accelerated Chongqing's economy. The growth rate of the GDP per capita from 1978 to 2007 reached 49%, higher than that of the western region, 31.6%.

The preceding analysis points to the two findings of China's regional inequality in the reform era. China's regional inequality is sensitive to the geographical scale, and the question as to whether the regional inequality increases or decreases cannot be answered based solely on the single-scale investigation. Although the interprovincial gap has declined in most years, the disparity between the three regions has kept rising. Fig. 2.8 reflects the ascending spatial concentration of economic growth and the widening gap between coastal and interior regions. In 1978, only three municipalities, Shanghai, Beijing, and Tianjin, had their GDP per capita falling within the two highest groups. All other provinces were poor; some coastal provinces (e.g., Shandong, Zhejiang, Fujian, and Hainan) were even among the poorest ones. In 2007, the provincial GDP per capita increased about 10 times compared to those in 1978. But all western and central

Table 2. 2 Growth rates of the provinces and regions of China, 1978-2007.

Province	GDP Per Capita (Yuan)				Growth Rate (%)		
	1978	1990	2000	2007	1978-1990	1990-2000	2000-2007
Eastern Region							
Beijing	1249	2801	6284	11880	10.36	12.43	12.72
Tianjin	1141	2326	5988	13637	8.65	15.75	18.25
Hebei	362	789	2404	5090	9.83	20.48	15.95
Liaoning	675	1495	3394	7399	10.12	12.70	16.85
Shanghai	2484	5035	12175	24391	8.56	14.18	14.33
Jiangsu	427	1293	4377	10352	16.89	23.85	19.50
Zhejiang	330	1102	4022	8945	19.50	26.50	17.48
Fujian	271	817	2978	6356	16.83	26.45	16.20
Shandong	315	837	2832	6672	13.81	23.85	19.37
Guangdong	367	1256	3574	7990	20.19	18.46	17.65
Guangxi	223	408	1152	2365	6.93	18.21	15.04
Hainan	310	798	2141	4144	13.09	16.84	13.36
Central Region							
Shanxi	363	784	1418	3881	9.66	8.08	24.82
Neimenggu	318	822	1900	5843	13.18	13.12	29.65
Jilin	381	938	2252	4984	12.15	14.02	17.33
Heilongjiang	559	1086	2337	4688	7.87	11.52	14.37
Anhui	242	585	1752	3636	11.84	19.93	15.36
Jiangxi	273	642	1793	3740	11.24	17.92	15.52
Henan	231	592	1643	3649	13.07	17.75	17.43
Hubei	330	819	2265	5050	12.34	17.66	17.56
Hunan	285	587	1506	3192	8.87	15.65	15.99
Western Region							
Chongqing	257	610	1667	3976	11.43	17.35	19.78
Sichuan	261	615	1498	3374	11.29	14.38	17.88
Guizhou	174	411	874	1689	11.40	11.27	13.31
Yunnan	223	565	1194	2191	12.75	11.14	11.92
Xizang	367	724	1618	3453	8.11	12.35	16.20
Shaanxi	292	732	1630	3509	12.57	12.29	16.46
Gansu	346	740	1608	3276	9.49	11.71	14.82
Qinghai	426	737	1395	2918	6.08	8.94	15.59
Ningxia	366	804	1621	3190	10.00	10.15	13.83
Xinjiang	317	878	1767	3265	14.76	10.12	12.10
Municipalities and Regions							
% of GDP Municipalities	15.31	13.24	12.83	12.74	----	----	----
% of GDP Eastern Region	52.30	54.90	60.90	62.50	----	----	----
Average GDPPC of Municipalities (Yuan)	1283	2693	6529	13471	9.16	14.24	15.19
Average GDPPC of Eastern Region (Yuan)	680	1580	4277	9102	11.03	17.07	16.12
Average GDPPC Central Region (Yuan)	331	762	1874	4296	10.85	14.59	18.46
Average GDPPC Western Region (Yuan)	303	682	1487	3084	10.42	11.80	15.34

Source: China data online.



Source: China Data Online.

Figure 2. 8 Spatial pattern of regional development in China in 1978 (a) and 2007 (b).

provinces, except Neimenggu, Jilin, and Hubei, dropped to the poorest group. Therefore, regional inequality has not been controlled even though the central government has made some effort.

Moreover, the municipalities have played an important role in the changing patterns of regional inequality. The four municipalities count for more than one-eighth of the total GDP, but the percentage decreased from 15.31% in 1978 to 12.8% in 2007 (Table 2.2). Since the economic reform, the coastal provinces have narrowed the gap to the municipalities; for example, Zhejiang and Jiangsu joined the two richest groups with Beijing, Tianjin, and Shanghai (Fig. 2.8). The catching up of the coastal provinces with municipalities is one of the major reasons for the declining interprovincial inequality. At the same time, the eastern region has further widened the gap with the central and western regions due to the three municipalities, as well as other affluent coastal provinces. The eastern region contributes to more than half of the total GDP; the percentage continued increasing from 52.4% in 1978 to 62.5% in 2007 (Table 2.2). The eastern region determines the overall trend of regional inequality. The strategy of upgrading Chongqing as a centrally administered municipality is aimed at stimulating western development and balancing the development of interior and coastal regions, but it takes a long period of time to develop Chongqing as well as its surrounding provinces. Some previous researchers have also explored the relationship among the individual provinces or grouped provinces, and the whole country (e.g., Ho & Li, 2008; Lu & Wang, 2002; Yu & Wei, 2003). However, this research emphasizes analyzing the municipalities and demonstrates the interaction between them and the overall regional inequality.

The spatial hierarchy of underlying mechanisms of regional inequality

We found a strong multicollinearity between FAIPC and FDIPC ($\rho = 0.8$), since FAI includes the fixed asset investment part of FDI. The potentially confounding effects of multicollinearity might cause misinterpretation of regression coefficients and standard errors of individual variables, although the overall regression model is not affected (Mason & Perreault, 1991). Also following our conceptual framework, we decide to drop the control variable FAIPC.

Thus, there are six independent variables in our regression models. The single-level regular regression model is used to compare and test whether the model is improved when the contextual and time levels are added. The two-level model separates the regional and provincial levels to examine the spatial-hierarchy of the mechanisms of China's regional inequality. The three-level model further adds the time scale, since the data set is composed of simple repeated data of 31 provinces at five time points. The time level explains the variation of growth of each individual province in a certain region with time.

The results of single-level, two-level, and three-level regression modeling are reported in Table 2.3 and reveal the following findings. First, spatial hierarchy does exist, and regional inequality is sensitive to the time dimension. In the single-level regression model ($R^2 = 0.84$), the six independent variables can explain 84% of variance of the GDPPC. There is a significant reduction in deviances from the single-level model to the two-level model ($p < 0.0001$), and from the two-level model to the three-level model ($p < 0.05$). The likelihood tests suggest that the adding of regional and time levels has statistically improved the regression models between economic growth and mechanisms

Table 2. 3 Results of the single-level and multilevel regressions, 1990-2007.

Single-Level			Two-Level			Three-Level		
Independent variable	Coefficient	P-value	Independent variable	Coefficient	P-value	Independent variable	Coefficient	P-value
FDIPC	34.8	0	FDIPC	36.1	0.0001	FDIPC	35.7	0.0001
EDU	10.95	0.04	EDU	8.5	0.11	EDU	6.5	0.19
SOE	-14.7	0.1	SOE	-13	0.15	SOE	-1.3	0.89
POPGR	-3.1	0.98	POPGR	-105.9	0.38	POPGR	-197.6	0.12
CDummy	-447.5	0.13	CDummy	-487.2	0.23	CDummy	-252.7	0.37
NPDummy	196.3	0.44	NPDummy	176.7	0.47	NPDummy	72.2	0.76
R-Square	0.84		Likelihood ratio test	<0.0001		Likelihood ratio test	<0.05	

Note: FDIPC-foreign direct investment; EDU-education level; SOE-the share of state-owned enterprises; POPGR-population growth rate; CDummy-coastal dummy; NPDummy-new policy dummy. *Source*: China data online.

This result also illustrates that the multimechanism framework becomes more valuable for analyzing the regional inequality of China with the spatial-temporal hierarchy.

Second, the multilevel modeling has offered a new method to improve the effectiveness of the single-level regression model to examine the mechanisms underlying regional development. The six independent variables represent the three mechanisms, globalization, marketization, and decentralization, respectively. Three variables, FDIPC ($p = 0$), EDU ($p = 0.04$), and SOE ($p = 0.1$, marginally) reflecting globalization and marketization are significant in explaining regional growth. When we further develop this model to two-level and three-level regression models, neither the EDU ($p = 0.11$, 0.19) nor the SOE ($p = 0.15$, 0.89) are significant. The FDIPC ($p = 0.0001$) becomes the only significant independent variable. Apparently, the multilevel model avoids exaggerating the influence of marketization and decentralization. Some recent research (Wei & Ye, 2009; Yu, 2006; Yu & Wei, 2008) has also integrated spatial factors into the regression

model by applying geographically weighted regression (GWR). The GWR model focuses on the spatial autocorrelation caused by the closeness of space, but is unable to reflect the influences of the spatial hierarchy as well as the time dimension on the regional development.

Third, the spatial-temporal hierarchy determines the relative importance of the mechanisms of China's regional inequality (Figs. 2.9, 2.10, and 2.11). FDIPC has caused significant variance of the GDPPC between provinces, regions, as well as different time points (Fig. 2.9). The variances become larger as FDIPC increases. As an indicator of globalization, foreign investment has become the key component of accelerating economic growth (Wei & Fan, 2000). With policy and geographical preferences, the eastern region accounts for more than three quarters of the total foreign investment since 1978 (Table 2.4). Its FDIPC was 3.5 and 10 times of that in central and western regions, respectively. The uneven distribution of foreign investment is the most important factor causing regional inequality in China. This result is different from Yu and Wei's work (2003) which identifies the SOE as the number one factor of China's regional inequality based on the data from 1990 to 2000. The difference reflects the transition China has experienced in the last two decades. Deng Xiaoping's southern tour highlighted market-oriented reform and determined the prominent position of marketization in economic development in the 1990s. However, in the 21st Century, China's economy has become more globalized through the accession to the World Trade Organization (WTO) in 2000, successfully hosting the 2008 Olympic Games, and being selected to run the 2012 World Expo in Shanghai. These events have strengthened the link between China and the world, and therefore globalization has gradually dominated the triple transitions. In contrast,

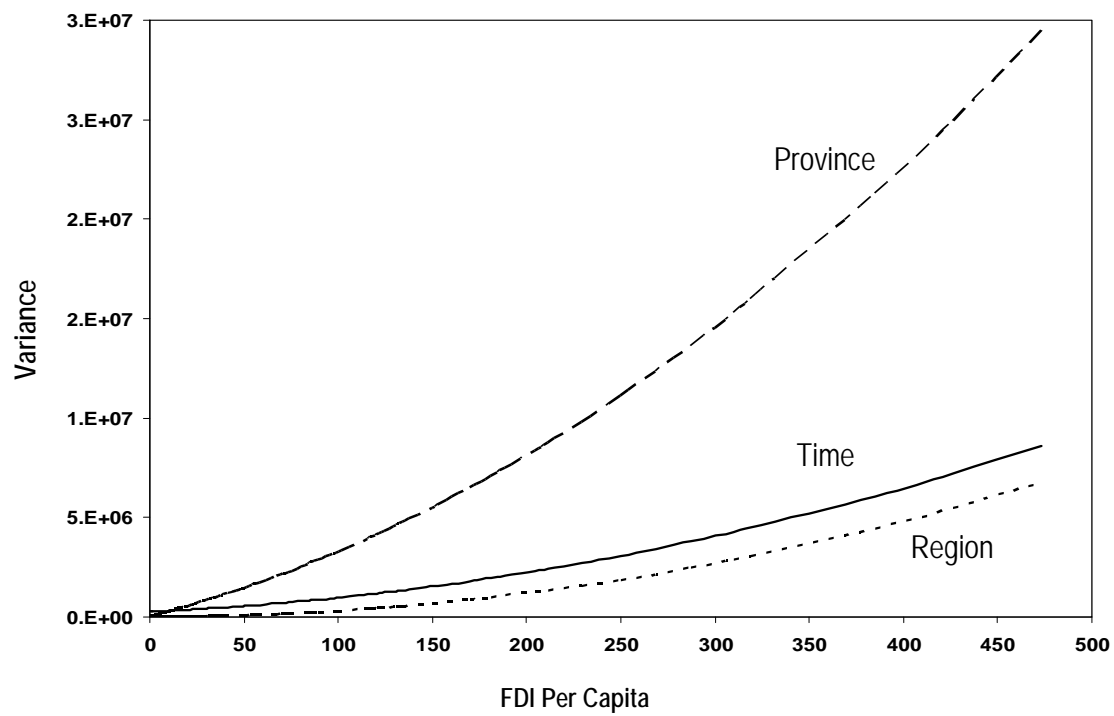


Figure 2. 9 Variance for FDI per capita at time, region, and province levels.

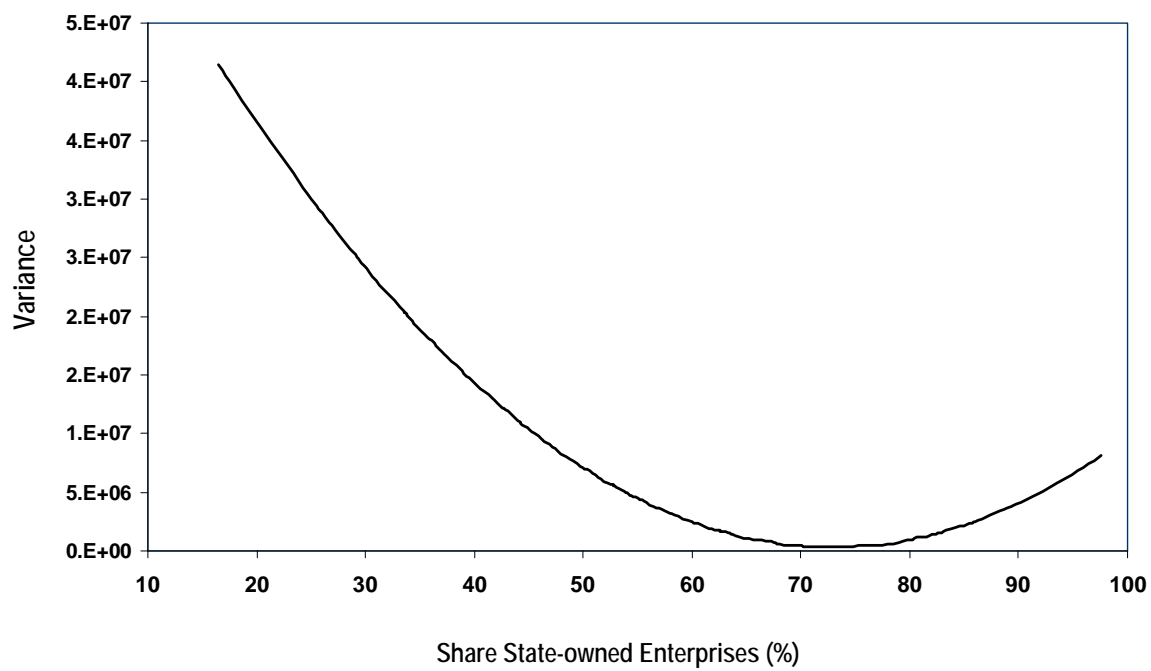


Figure 2. 10 Variances for share of state-owned enterprises at province level.

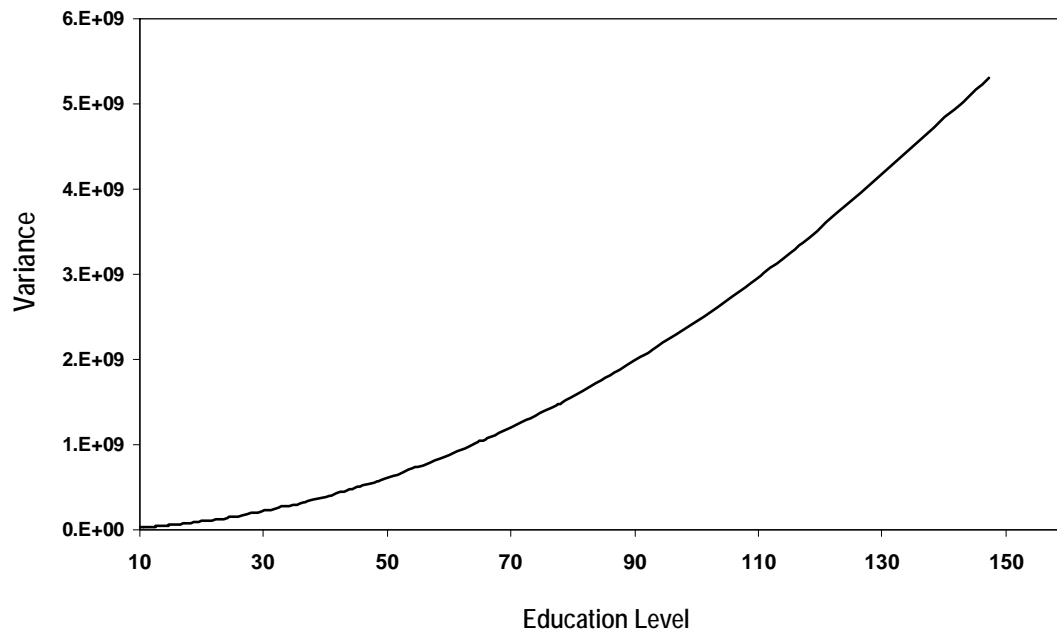


Figure 2. 11 Variances for education level at province level.

Table 2. 4 FDI and FDI per capita of three regions.

Region	FDI (\$ Million) / Percentage				FDIPC (\$)			
	1990	1995	2000	2007	1990	1995	2000	2007
Eastern Region	3046 / 94%	32947 / 87%	35411 / 88%	96036 / 78%	6.5	67.0	66.0	169.8
Central Region	112 / 3%	3378 / 9%	3700 / 9%	21663 / 18%	0.3	7.9	8.3	49.0
Western Region	76 / 2%	1441 / 4%	1332 / 3%	4922 / 4%	0.3	5.2	4.6	16.9

FDI: foreign direct investment. *Source*: China Data Online.

indicators, the SOE and EDU, only lead to the variance of the GDPPC between provinces (Figs. 2.10 and 2.11). With the emergence of various types of enterprises, the share of state-owned enterprises has kept dropping, and the influence on economic growth has been gradually fading. Education level is a driving force for economic development, but the role is very limited. Two decentralization indicators, the coastal dummy and the new policy dummy, are not significant to regional growth at all. This indicates that the

interregional competition stimulated by decentralization is not sufficient enough to alleviate the regional imbalance caused by globalization and marketization. It also demonstrates that the new strategies to reduce regional inequality have not obtained the expected results, which is consistent with the results of the CV, Gini, and Theil index.

Discussion and Conclusion

This paper investigates regional development in China in the reform era. We found that regional inequality at different geographical scales have shown various patterns, which is influenced greatly by the four municipalities. The interprovincial inequality has declined due to reducing disparities between the coastal provinces and the municipalities, while the interregional inequality has been rising due to the fact that the eastern region is still far ahead of the central and western regions. Without the municipality effect, both interprovincial and interregional inequalities decline significantly. The spatial concentration of regional development has increased, and the eastern region has accounted for a higher percentage of the total GDP than the early stage of the economic reform. Therefore, the new development strategies for reducing regional inequality have not achieved the expected results. This research also contributes to the literature by applying the multilevel modeling to recognize the spatial-temporal hierarchy of the mechanisms and to identify the relevant importance of the triple transitions. We found that globalization is the dominant mechanism causing regional inequality, since the important driving force of economic growth, the FDI, is extremely unevenly distributed among the three regions. The influence of marketization has decreased gradually with the

decline of the state-owned enterprises. And decentralization of the central authority is still limited in their ability to solve the inequality problem.

Our study recognizes that the multimechanisms framework is capable of explaining China's regional development. Unlike the convergence or divergence theories which only emphasize free mobility of capital or government intervention, the multimechanisms include the state, local agent, and global forces (Wei, 2000). They represent "from above", "from below", and "from outside" forces of development (Wei & Fan 2000, p. 466), which have usually been interwoven. The municipality effect is an example of how these forces have driven regional growth; because the municipalities have more preferential policies from the central government, higher local autonomy, and can attract more foreign investment. The spatial distribution of the municipalities is one reason for serious regional inequality, since the three richest municipalities (Beijing, Shanghai, and Tianjin) are located in the eastern region. In addition, the impact of each mechanism has been shifting with time due to the changing policy orientation. In the first phase of economic reform, the key strategy was decentralizing power from the central government to the local government, mainly in the eastern region. Marketization became the dominant direction of the reform in the 1990s, and globalization was the most important mechanism after 2000. Therefore, the spatial and time structures of the multimechanisms have direct effect on regional development. Our analysis on the spatial-temporal hierarchy makes the multimechanisms framework more effective at explaining regional inequality in China.

The above findings have at least three theoretical and policy implications. First, neither neoclassical theories nor "new convergence" is capable of explaining regional

development in China, due to the fact that they all de-emphasize the role of the state and policies. Second, the new strategies for reducing regional inequality should focus on a few influential cities in interior regions. The current strategies cover too many provinces, and they have not gained the expected results. For instance, within the past 10 years, the central government has proposed the “Western Development Program” (12 provinces); “Reviving Northeastern Region” (3 provinces), and “The Rising of Central China” (9 provinces). In contrast, in the 1980s and 1990s, China only selected some coastal cities and special economic zones as growth poles, and then eventually accelerated the development of the whole eastern region. As the municipalities have played leading roles in regional development, further reform of key interior cities might drive the development of these cities and their surrounding areas. The GDP per capita of Chongqing (southwest) quickly rose in the western region after it was promoted as the municipality (Table 2.2); however, it is not sufficient to stimulate the broad central and western regions. We suggest the central government select a few big interior cities to develop into economic growth centers in the near future, and then expand to a larger range of interior cities in the next 10 years. We expect that the radiation effects from these cities would gradually bring prosperity to the whole central and western regions in the long run. Third, at the policy level, the central and local governments need to further improve the investment environment and offer more preferential policies to attract foreign investment in those selected cities, since FDI has been the most important factor causing the regional gap, as shown in this research. The combination of the rich resources in the western region, adequate labor in the central region, and the potential capital would boost economic growth in interior regions.

In conclusion, this paper has documented the patterns of China's regional inequality, identified the significant effects of the municipalities, and implemented multilevel modeling to reveal the spatial-temporal hierarchy and the importance of multimechanisms. This research could be improved by considering the spatial autocorrelation among provinces and regions. Some researchers have demonstrated the strengthening positive spatial autocorrelation of China's development (Yu, 2006; Yu & Wei, 2008). The integration of the GWR and multilevel modeling might present new findings of China's regional inequality.

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CHAPTER 3

HEALTH CARE, MORTALITY, AND ECONOMIC TRANSITION IN CHINA^{3 4}

Abstract

Two geographers specializing in China analyze that country's health care inequality from 1990 to 2008, for the purpose of: (1) examining spatial-temporal variations of health care inequality at multiple scales (the regional, provincial, and county levels); (2) exploring whether economic growth and transition to a market economy have exacerbated the unevenness of health care; and (3) analyzing the impact of health care inequality on health outcomes, especially mortality. The authors apply GIS-based spatial statistical methods to detect spatial-temporal patterns of health care, and use multilevel regression to examine the linkages between health care, mortality, and regional economic inequality, and ultimately to assess the sensitivity of health care inequality to geographic scale and examine whether reforms implemented to date have resulted in more equitable access to health care. The paper also demonstrates how the concurrent transitions of decentralization, marketization, globalization, and urbanization in China have interactively contributed to health care inequality and mortality.

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⁴ Li, Y. and Wei, Y.H.D. (2010). Health care, mortality, and economic transition in China. *Eurasian Geography and Economics*, 51 (6), 767–787.

Introduction

Health care as a research topic has attracted increasing interest from both the public and academic communities. Recently, health inequality has become a burning topic in both developed and developing countries. China's economic reform since 1978 has dramatically accelerated economic growth as well as people's living standards. However, the reform has also generated negative impacts on social inequality (e.g., Zhao, 2006). In particular, disparities in health care have been growing rapidly with widening economic inequality. According to the World Health Organization estimates in 2000, China ranked 188th among 191 member states in terms of "fairness of financial contribution to health systems" (Cai, 2009). Subsequently, a survey of 10 thousand Chinese households indicated that health care is the leading concern among China's population (see Hu et al., 2008).

Following economic and health care reforms, China's health care sector has changed from a centrally planned to a market-based system (Ma et al., 2008; Chou and Wang, 2009). Before reform, the central government set low prices for health services and provided budgetary support to health care providers, improving citizens' access to health care in both rural and urban areas as well as both poor and relatively more affluent provinces. China under Mao had three major types of medical insurance schemes (Tang and Wu, 2000; Wu, 2003; Zhao, 2006): (1) a Government Insurance Scheme (*Gongfei Yiliao*) financed directly by the government, which covered people working in state organizations and other institutes, as well as college students; (2) the Labor Insurance Scheme (*Laobao Yiliao*), which provided full or partial coverage to employees (and family members) of state or collective enterprises, supported by the welfare funds of

those enterprises; and (3) the Cooperative Medical System (*Hezuo Yiliao*), mainly subsidized by the welfare funds of the collective enterprises, and primarily covering rural residents.

Subsequent reforms gradually replaced this far-reaching social welfare approach to health care with the current system, which has been criticized because of heavy reliance on private financing, a dramatic reduction in health insurance coverage, and rising costs to patients (Yip and Hsiao, 2008; Wagstaff and Lindelow, 2008). The central government devolved the financial burden of public health services to the provincial and county governments, making them responsible for meeting the health care needs of local residents (Akin et al., 2005). At the same time, local governments have obtained more authority to manage their own health care sectors (Bloom and Gu, 1997), for instance, to establish (or purchase existing) health care facilities and set the salaries of health staff. Not surprisingly, wealthier areas can afford high-quality facilities and attract more skilled physicians with better salaries, while the poorer regions have insufficient revenues to adequately develop their health care systems. Because most local governments are incapable of fully covering their health care expenditures, user fees have been increased to finance the major proportion of service delivery. As a result, health care has become too expensive for most of China's people.

The literature reflects a growing concern about inequalities in health care and health outcomes in China. A study by Liu et al. (1999) revealed a widening gap in health status between urban and rural residents after the reforms, with a more unequal distribution of income and health care utilization. Zhang and Kanbur further (2005) documented the increasing disparity of infant mortality rates between rural and urban

areas, and coastal and interior areas, arguing that uneven access to health care is a driving force underlying the expanding rural-urban difference in these rates. Chou and Wang (2009) found no single nationwide convergence in health care expenditures, but identified convergence by cluster. They demonstrated, using systematic quantitative methods, that income and regional fiscal disparities contributed to the emergence of relatively well or poorly served clusters. However, these investigators have rarely explored health care and the population's health from a geographical perspective. For example, China's regional inequality has been demonstrated to be sensitive to spatial scale and geographical agglomeration (Wei and Ye, 2009). As a consequence of such regional economic inequality, disparities in health care and health can be better understood by analyzing spatial association/heterogeneity.

This paper aims to provide a spatial-temporal investigation on China's health care distribution from 1990 to 2008, and to examine the relationship between health care, mortality, and economic transition. The next section summarizes the literature and conceptual framework, followed by a discussion of data and methodology. Then the variation of health care and mortality against the background of economic development and social transitions is analyzed. Conclusions of the paper's major findings are presented in the last two sections.

Literature Review and Objectives

Although there has been a series of theoretical debates on the relationship between economic inequality and health outcome, health care only plays a minor role in these theories. The two well-accepted pathways are the psychosocial and neo-material

mechanisms. Wilkinson (1996) proposed the “social cohesion model,” a leading theory among the psychosocial explanations. At the social level, Kawachi and Kennedy (1997) demonstrated that income inequality leads to increased mortality due to the erosion of social cohesion and trust. At the individual level, social comparison leads to feelings of relative deprivation and unhealthy behaviors such as smoking and drinking.⁵ In contrast, the neo-material mechanism emphasizes individual material resources and macroeconomic conditions (Lynch et al., 2000). At the individual level, people at the lowest rung on the social hierarchy have only limited material resources necessary for good health, such as nutritious food, clean water, adequate housing, safe working conditions, and sufficient access to medical care. Wealthier people can minimize the risks of accident or disease by their easy access to the aforementioned social resources. From the macro perspective, public goods, environment, social security, and overall living conditions also have significant effects on health.

Nonetheless, most Western scholars consider health care as not a particularly important factor in explaining socioeconomic inequalities in health (Robert and House, 2000). In fact, however, unequal access to (and quality of) health care does affect people’s health outcomes, even though countries have been trying to equalize health service delivery. Some people are still not able to obtain needed medical services to prevent or reduce the risk of disease due to poverty, race, inadequate insurance coverage, or spatial unevenness of service availability (Kasper, 2000). For example, in the U.S., 14% of cervical cancer patients were diagnosed after metastasis in low-income areas, because poor women could not afford screening tests for detecting cancers at an early

⁵For example, Kondo et al. (2008) conducted a study in Japan and found that higher relative deprivation of income, combined with age and occupational factors, had a negative impact on health.

stage; in higher income areas only 5% of diagnoses were made after metastasis (RWJ, 1993).

Compared to Western theories and research, the study of China's health inequality still remains limited and lacking in systematic theoretical analysis. Some scholars follow the Western theoretical pathways by exploring the relationship between health and income inequality (e.g., Li and Zhu, 2006; Pei and Rodriguez, 2009). More research emphasizes the unique characteristics of China's health inequalities under its economic transition. First, scholars have examined the impact of reforms on the health sector (e.g., Akin et al., 2005; Zhao, 2006; Hu et al., 2008; Liu et al., 2008; Yip and Hsiao, 2009). Zhao (2006) proposes that the further improvement of the population's health has been impeded by the deterioration of the health care system, reflecting the erosion of state-provided insurance coverage and the growing unevenness of wealth distribution. Second, health inequality has been analyzed from different spatial perspectives, such as between rural and urban (Zhang and Kanbur, 2005), within rural areas (Anson and Sun, 2004), and among regions (Yip and Mahal, 2008). Li and Zhu (2006) concluded that both absolute income and income inequality significantly affected self-rated health; the relationship between income disparities and health exhibited an inverted-U pattern differing from the linear one prevailing in Western countries. Third, a few researchers have investigated health care inequality and the underlying factors (Zhan, 2005; Eggleston et al., 2008; Wang et al., 2009; Zhou et al., 2009). Wang et al. (2009) have proposed that inadequate government investment as well as weak supervision and administration have contributed to the high cost and inequality in health care in the past two decades.

Based on the literature review above, three areas appear to merit further research.

First, health care inequality should be considered as a more important factor linking health outcomes and economic inequalities. The role of health care should not be dismissed, because unequal access to and quality of medical care exist in all countries, and especially in developing countries. Consequently, our research, rather than following the psychosocial pathway, more closely tracks the neo-material mechanism with its focus on health care distribution under China's economic transition. Second, spatial patterns at multiple scales of health and health care inequality need to be explored. Whether inequality is measured in large or small areas leads to different conclusions and a multiscale study would effectively avoid possible misinterpretation. Third, spatial-temporal analysis of the relationship between health care distribution and regional economic inequality is still lacking. Existing studies largely depend on cross-sectional models and survey data, and time series econometric methods are rarely used (Chou and Wang, 2009). Yet the spatial-temporal hierarchy is a crucial characteristic of China's economic transition (Li and Wei, 2010), and its effect on health care inequality has not been examined.

The objectives of this paper are thus threefold: (1) to examine the spatial-temporal variations of health care in China at multiple scales (region, province, and county levels) from 1990 to 2008; (2) to analyze spatial patterns of mortality and to shed light on the relationship between health care inequality and mortality; and (3) to explore whether China's economic transition has caused health care unevenness and further influenced people's health outcomes by using hierarchical spatial-temporal models.

Analytical Framework

Mainland China has 31 provincial-level administrative units (hereafter provinces) and 2862 county-level administrative units (hereafter counties⁶) that are traditionally grouped into three regions: eastern/coastal, central, and western (Fig. 3.1). Each region has unique political, economic, cultural, and geographical characteristics (Li and Wei, 2010). The eastern coastal region has initial natural and location advantages and has also benefited from preferential economic policies in the reform era. Living conditions and public resources are better than those in interior regions. The central region is agriculturally oriented and highly populated. The health care reform, especially the abolition of the rural Cooperative Medical System has had a pronounced impact on the rural residents in this region. The western region is vast, sparsely populated, less developed, and mountainous in many areas. Access to health care is more difficult than in the eastern and central regions because of the rugged physical conditions.⁷

China since 1978 has been experiencing the four transitions of decentralization, marketization, urbanization, and globalization (Wei 1999, 2007), which have reshaped the entire health care sector. Describing each in turn, we can say that, first, the central government has decentralized fiscal authority and devolved responsibility to local governments for economic and social development, including health care. As budgetary transfers from the central to the local level have decreased, poor provinces have had to cut spending on health care.

⁶The county-level administrative units, in turn, include districts (*qu*) and counties proper (*xian*). Districts are completely urban, whereas the counties are predominantly rural.

⁷It should be noted that Hainan and Chongqing provinces were separated from Guangdong Province (1989) and Sichuan Province (1997), respectively, and became two new provincial-level administrative units during the course of the period covered in this study. In order to maintain data consistency, this research treats them as provinces for the entire (1990–2008) study period.

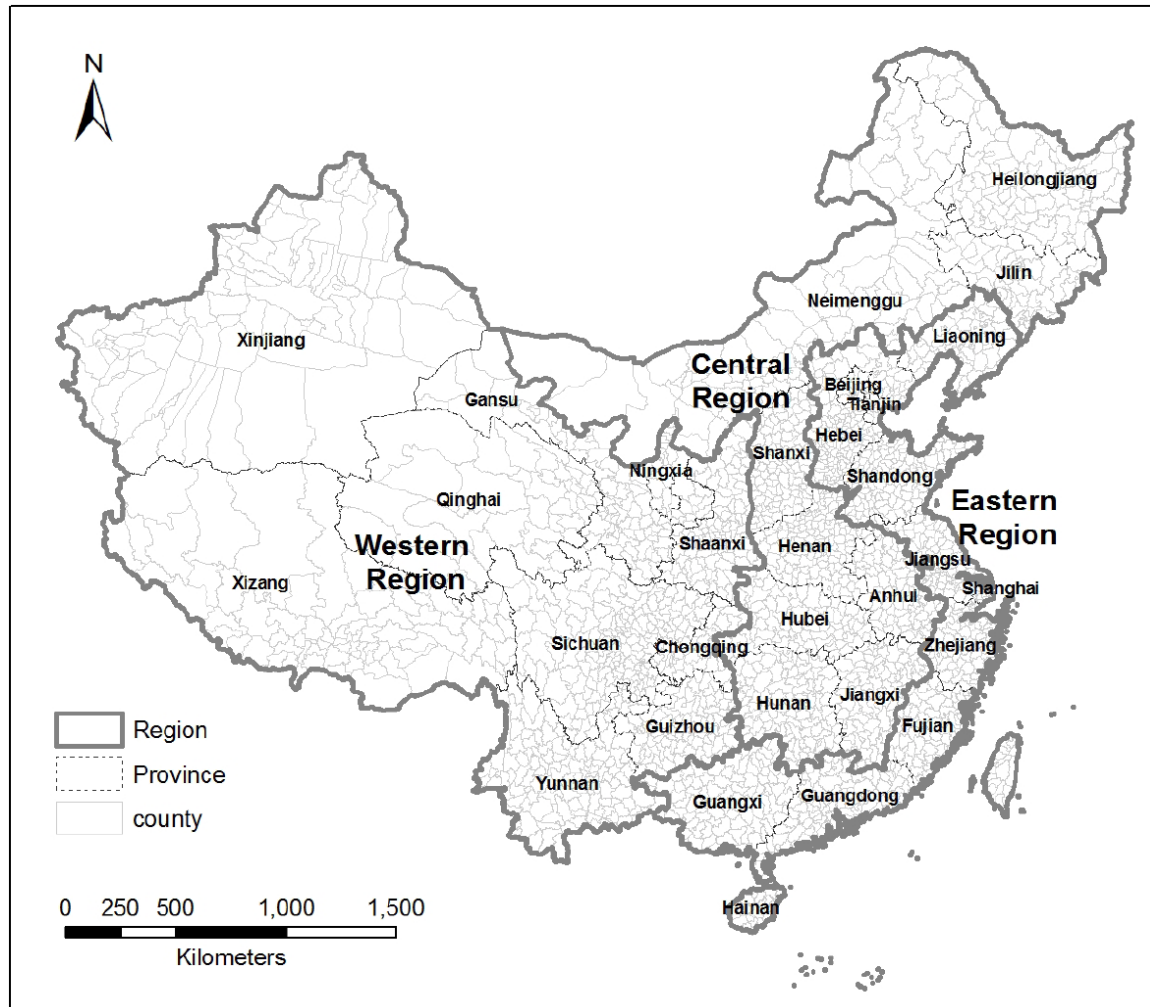


Figure 3. 1 Regions, provinces, and counties in China.

Second, since the health care reform in 1985, a market-driven economy has operated in the health care sector (Wang et al., 2007). State-owned enterprises, government agencies, and institutions formerly had their own clinics or hospitals providing medical services for employees. After the reform of state-owned enterprises, the government established a new insurance coverage system cofunded by the government, employer, and employee, which covers some 50% of the urban population. In rural areas, the old Cooperative Medical System, which covered about 90% of the rural

population became insolvent. Since 2003, the government has been active in establishing a new Cooperative Medical System and has increased financial support for it. However, limited government funding is only adequate to cover a small portion of rural residents' health care costs. The burden of health care has thus been shifted from the state to individuals in many cases. People living in poor regions not only receive a smaller degree of health-system coverage, but also are less likely to seek health care due to the high out-of-pocket costs (Liu et al., 2008).

Third, selective urbanization is another reason for both health and economic inequality in China (Anson and Sun, 2004). Due to shortages of labor in the coastal region, the government has relaxed the household registration system (*Huji Zhidu*, or *hukou*) and encouraged rural residents to migrate from rural to urban areas and from the interior to the coastal region.⁸ Typically, younger and healthier cohorts are better positioned to take advantage of these opportunities and migrate to urban areas, whereas the older people opt to remain in the villages.

Finally, globalization is the principal mechanism driving China's regional inequality (Li and Wei, 2010). With the weakening of the public-sector health system, economic development (and the availability of capital) has become a more important factor in shaping the pattern of health and health care. Consequently, globalization has a relevant influence. Given the bias of foreign investment toward coastal areas, globalization may raise regional economic inequality and concomitantly intensify health inequality (Wei et al., 2010).

Both China's administrative divisions and policy-making apparatus have a

⁸For background on the household registration system, see Chan (2009).

hierarchical structure (Li and Wei, 2010). Policies are executed (typically top-down) through multiple government levels. Though the three regions (eastern/coastal, central, and western) are not official administrative divisions, some of the central government's policies and strategies nonetheless vary among them, reflecting their uniqueness. For example, the central government recently has pursued preferential policies in the western region under the “Western Development Program” (*xibu da kaifa*). From 1999 to 2009, 78.62 billion yuan (RMB) were invested in improving health care in the 12 western provinces, accounting for 43.3% of the nationwide health expenditure in those years (Zhang, 2009). The temporal dimension is also crucial because policies involving the health care sector have changed over time (e.g., the economic reform in 1978, health care reform in 1985, the establishment of the urban health insurance system in 1998, and the new Cooperative Medical System in 2003). Therefore, it is necessary to analyze the spatial-temporal hierarchy of health care distribution as well as of economic transition.

Based on the above analysis, we offer three hypotheses that are tested in the remainder of this paper: (1) that China's health care inequalities are sensitive to spatial scale; (2) that health care is a significant factor in explaining the unequal distribution of mortality in China; and (3) that health care inequality is affected by the spatial-temporal hierarchy of economic transition.

To test these hypotheses, this paper investigates China's health care inequality within a multiscalar, multimechanism, and multilevel framework. The spatial pattern of health care is examined at five different geographic scales: (1) interregional, among the three regions (discussed above); (2) interprovincial, among all provinces; (3) intraregional, among the provinces of each region; (4) intercounty, among all counties;

and (5) intercounty within each region. The multimechanisms of economic transition, decentralization, marketization, and globalization have been widely used to explain China's regional economic inequality (e.g., Wei, 1999; He et al., 2007; Li and Wei, 2010). This research adds urbanization to the triple transition framework to explain health care and mortality inequality because rapid urbanization has aggravated a series of social problems. The spatial-temporal hierarchy of health care and mortality is explored with a multilevel framework. The time dimension is selected as the first level, and regions and provinces are the second and third levels, respectively.

Data and Methodology

Data

Statistical information used in this study includes basic health and socioeconomic data (Table 3.1) and GIS shapefiles.⁹ China Data Online (<http://chinadataonline.org>) provides province-level health and socioeconomic data from 1990 to 2008 and county-level health data from 1997 to 2008. In this paper, we use the number of health institution (hospital) beds per 10,000 persons as a measure of the basic level of health care; these data are readily available for both provinces and counties. Similarly, we selected the widely used measure of mortality to reflect the level of health outcome (e.g., see Subramanian and Kawachi, 2007). The 13 independent variables measuring economic development and transition (discussed further below) are: constant GDP per capita (GDPPC); local budget expenditure (FINEXP); per capita GDP generated by transportation, postal service, and telecommunication (TRAN); the share of state-owned

⁹The GIS shapefiles are boundary files of China provinces and counties, which were downloaded from the China Data Center (<http://chinadatacenter.org>).

Table 3. 1 Dependent and independent variables

Class	Type	Variable
Dependent variable	Mortality/Healthcare	Death rate/Number of hospital beds per 10,000 persons
Independent variables	Decentralization	Local budget expenditure (FINEXP)
		Per capita fixed asset investment (FAIPC)
	Marketization	The share of state-owned enterprises (SOE)
		Institutions of higher education per 10,000 persons (EDU)
	Globalization	Foreign direct investment per capita (FDIPC)
	Urbanization	Population density (POPDEN)
		The percentage of migrants (MI)
	Hybrid of multimechanisms	Per capita fund for promoting technical innovation (INNO)
		GDP generated by transportation, post, and telecommunication (TRAN)
		Coastal dummy (coastal province =1; others=0) (CD)
		Western region dummy (western province =1; others=0) (WRD)
	Economic development	Constant GDP per capita (GDPPC)
	Control Variable	Population growth rate in past year (POP)

enterprises in fixed-asset investment (SOE); higher educational institutions per 10,000 persons (EDU); foreign direct investment per capita (FDIPC); population density (POPDEN); percentage of migrants (MI) in overall population; coastal dummy (CD); western region dummy (WRD); innovation fund (INNO); per capita fixed asset investment (FAIPC); and population growth rate in the past year (POP).

Methods

This investigation of health care in China uses the coefficient of variation (hereafter CV). The CV, defined as the ratio of the standard deviation to the mean, is a popular measurement of inequality.¹⁰ However, CV only reveals overall inequality but has limitations when it comes to detecting spatial agglomeration. Consequently, we

¹⁰For brief further discussion of the various inequality measures, see Fan and Sun (2008, pp. 6–7, 19–20).

utilized an additional measure, Moran's I, to analyze spatial autocorrelation among provinces and to uncover further spatial inequalities in health care in China. Global Moran's I (Anselin, 1995) is a measure of overall clustering and is assessed by testing a null hypotheses. Rejection of this null hypothesis suggests a spatial pattern or spatial structure. Significance is tested by comparison with a reference distribution obtained by randomly permutating the observed values (Anselin, 1995).¹¹ However, even within the same dataset, different degrees of spatial autocorrelation may exist. Consequently, we applied Local Moran's I, one of the so-called Local Indicators of Spatial Association (LISA; Anselin, 1995), to examine the association for each unit and identify the type of spatial correlation. Local Moran statistics can not only indicate local spatial clusters, but also diagnose outliers in global spatial patterns.

The relationships between health care inequality, mortality, and economic transition are examined through multilevel regression modeling, which makes it possible to recognize spatially and temporally hierarchical structures. Studies on health inequality generally use cross-sectional models, ignoring the impacts of time-dependent variables (Chou and Wang, 2009) and treating the units of analysis as independent observations. For example, ordinary least squares (OLS) and logistical regression are used widely (e.g., Kondo et al., 2008), when the relationship under study is constant over space and time. Multilevel modeling identifies data hierarchies by computing residual components at each level. Our research utilizes the pooled cross-sectional and time-series data sorted at three levels: time (from 1996 to 2008), region (eastern, central, and western region), and province (31 province-level units). We also use single-level (simple) regression to

¹¹Two types of weight matrix are often used—spatial linkage based on distance and border sharing. Considering the frequent flow of capital and labor occurring even among nonadjacent provinces, we selected the inverse distance function in calculating Moran's I.

compare results with the three-level regression model. The equation for the multilevel hierarchical model is:

$$y_{ijt} = \beta_0 + \beta_1 x_{ijt} + u_t + r_{jt} + e_{ijt}$$

where y_{ijt} is the dependent variable in region j at year t ; x_{ijt} is the independent variable in region j at year t ; u_t is the standard error at year t ; r_{jt} is the standard error of region j at year t ; and e_{ijt} is the standard error of i in region j at year t .

Two regression models are specified. Model One examines how health outcomes have been affected by health care access during the process of reform. The dependent variable is mortality, with the independent variables comprising the number of health institution beds per 10,000 persons (health care) and the 13 independent variables indicating economic development and social transitions (Table 3.1).

Model Two analyzes whether social transitions have changed the pattern of health care inequality in China. The number of health institution beds per 10,000 persons is the dependent variable. In accordance with the recent literature on China's regional development (Yu and Wei, 2003; Yu, 2006; Li and Wei, 2010), this research chooses the following independent variables (Table 3.1):

1. GDP per capita (GDPPC) in constant prices reflects economic development. We convert per capita GDP data in current prices into 1978 constant prices based on the official GDP deflators. Here, GDP includes all gross domestic products.

2. Decentralization is indicated by per capita indices for local budget expenditure (FINEXP) and fixed asset investment (FAIPC). FINEXP and FAIPC show inputs from local governments and support from the central government (and other sources), respectively. Higher FINEXP and lower FAIPC reflect more decentralized power.

3. Marketization is proxied by the share of state-owned enterprises in a province's fixed-asset investment (SOE) and institutions of higher education per 10,000 persons (EDU). A higher SOE represents a lower level of marketization.

4. Urbanization is represented by variables for population density (POPDEN) and percentage of migrants (MI) in the overall population.

5. Foreign direct investment per capita (FDIPC) represents the force of globalization.

6. Hybrid (multimechanism) indicators include those for the coastal dummy (CD), western region dummy (WRD), innovation fund (INNO), and per capita GDP generated by transportation, postal service, and telecommunications (TRAN). CD is a locational factor reflecting increased decision-making authority and special policies from which the coastal provinces have benefited during economic reform.¹² WRD is used to examine the influence of China's new development strategies on health care distribution in western China.¹³ Since 1999, the central government has increased investment and implemented new preferential policies in the western provinces. INNO and TRAN represent local creativity and the capacity for exchanging labor and materials, as well as information, respectively.

7. The population growth rate over the past year (POP) serves as a control variable.

¹²A coastal province has a value of 1, and a noncoastal province 0.

¹³Provinces included in China's official Western Development Program are assigned a value of 1, whereas other provinces are assigned a 0.

Results

Temporal and spatial inequality of healthcare

Market reforms and rapid economic development offer strong economic foundations for expanding China's health care system. The total expenditure on health care increased fifty-fold from 1978 to 2002 (Cai, 2009). The number of doctors rose from 1,033,000 in 1978 to 2,082,400 in 2008 (China Data Online). Health care facilities, for example, hospital beds, have also been dramatically enhanced. At the same time, the entire health care sector has experienced structural reconstruction during the reforms.

China started reconstructing its medical insurance systems in 1998 and since then, health expenditures incurred by the government were gradually reduced. The portion of health costs supported by the government reached its lowest point, 15%, in 2000; and that paid by patients achieved its peak, 60%, in 2001 (Xiong, 2008). The state cost-cutting policies made it more difficult for people to access to health care, especially in the rural area. In order to help the rural residents get basic health care, the government introduced a new Cooperative Medical System in select rural locations in 2003, followed by its gradual expansion to the entire country. These policies have brought fundamental changes to health care inequality patterns, and coefficient of variation (CV) reveals the temporal variations (Figs. 3.2 and 3.3). The interregion, interprovince, and intercounty inequalities all remained relatively flat in 1990s, fluctuated from 2000 to 2003, and then declined in the five consecutive years since 2004 (Fig. 3.2). The inequalities of intraregion and intercounty within region presented contrasting trends, with the former going down smoothly throughout the study period while the latter jumped sharply after 2000 (Fig. 3.3). The eastern region had the lowest inequality between counties but

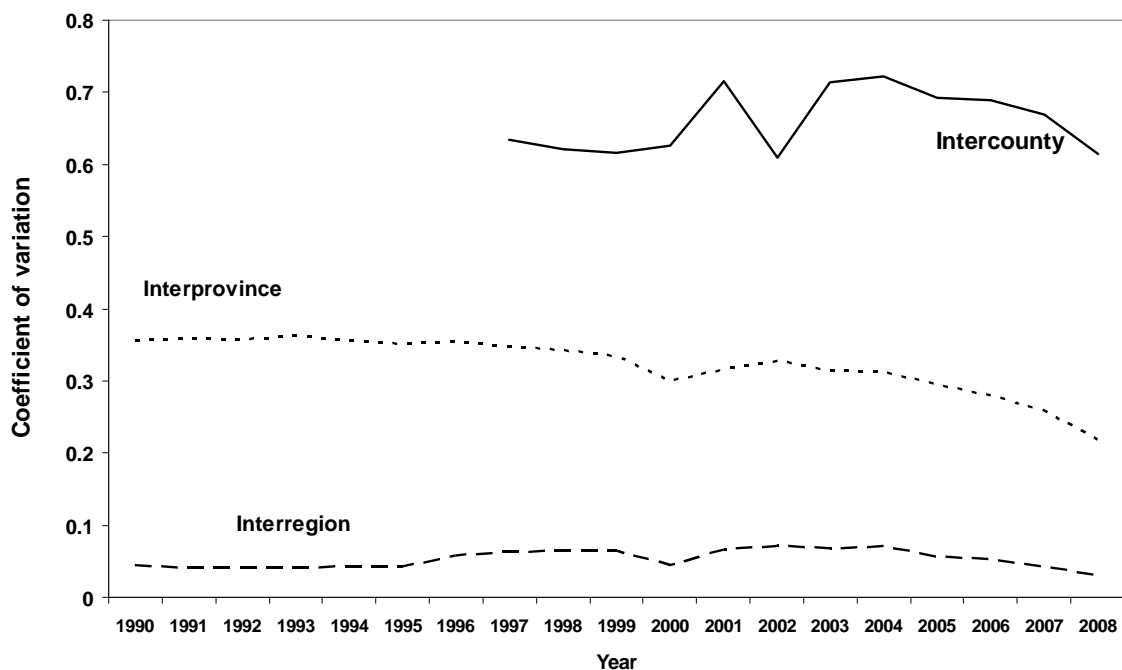


Figure 3. 2 Interregion, interprovince, and intercounty inequalities of health care (number of hospital beds per 10,000 persons) in China, 1990 to 2008.

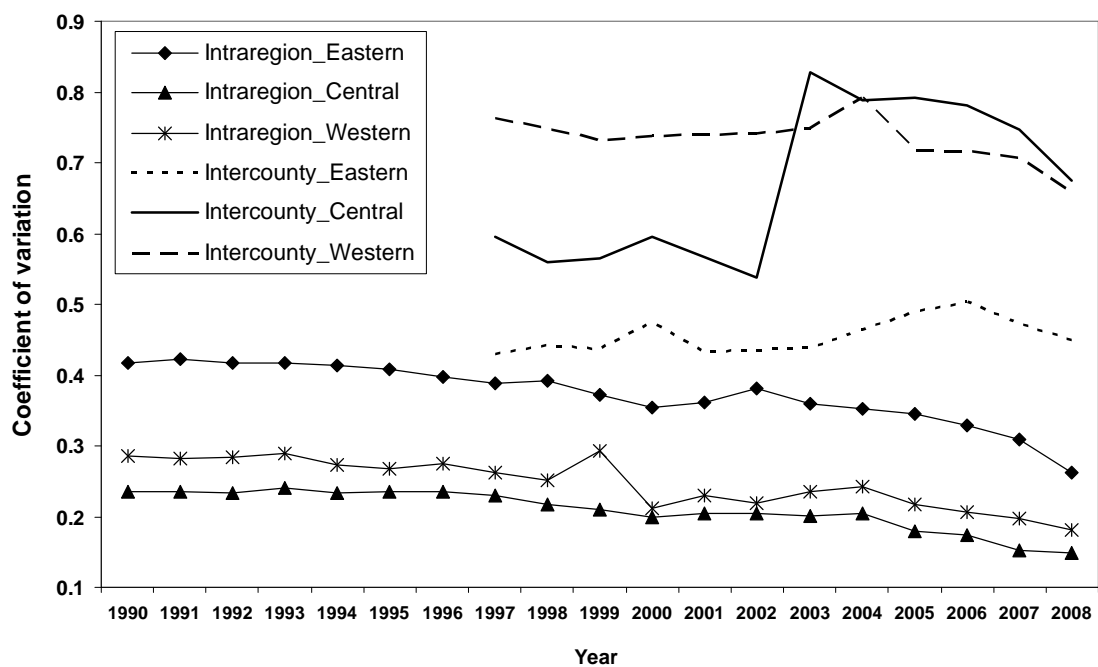


Figure 3. 3 Intraregion and intercounty inequalities of health care (number of hospital beds per 10,000 persons) within each region in China, 1990 to 2008.

highest among provinces. The central and western regions showed more complex patterns. The provincial inequality in the central region was always below that in the western. The intercounty disparity in the agriculture-oriented central region has exceeded that in the western since 2003.

The above analysis reveals that China's health care inequality is sensitive to the spatial scale; the smaller the spatial scale, the larger the disparity. The CVs of interregion, interprovince and intercounty inequalities range from 0.03 to 0.07, from 0.22 to 0.36, and from 0.61 to 0.72, respectively (Table 3.2). With the increasing investment on health care in the western region, the gap among the three regions has been narrowed down at all regional, provincial, and county levels. However, it is still too early to reach definite conclusions on the effects of the reforms on controlling health care inequality because of the rising finer-scale disparities within the regions. Macro-level unevenness declined at the expense of increasing inequality at the micro-level. The enlarged difference reflects that rural-rural and more particularly rural-urban inequalities within provinces or regions have worsened. Medical services are highly agglomerated in urbanized areas because

Table 3. 2 Coefficient of variation (CV) of health care in China, 1990 to 2008.

Scale	Region	1990	1995	1997	2000	2005	2008
Intercounty	All	N/A	N/A	0.63	0.63	0.69	0.61
Interprovince	All	0.36	0.35	0.35	0.30	0.29	0.22
Interregion	All	0.04	0.04	0.06	0.05	0.06	0.03
Intraregion	Eastern	0.42	0.41	0.39	0.35	0.34	0.26
	Central	0.23	0.23	0.23	0.20	0.18	0.15
	Western	0.29	0.27	0.26	0.21	0.22	0.18
Intercounty	Eastern	N/A	N/A	0.43	0.48	0.49	0.45
	Central	N/A	N/A	0.59	0.60	0.79	0.67
	Western	N/A	N/A	0.76	0.74	0.72	0.66

Source: Calculated by authors based on data of China data online.

only 20% of health care expenditures have been made in the rural areas where more than 70% of the Chinese people live (Evans and Xu, 2008; Chou and Wang, 2009).

In order to further explore the complexity of China's health care inequality, the changing trajectories of health care of individual provinces are summarized in Fig. 3.4. Based on the research of Wei and Ma (1996) and Yu and Wei (2003), we classified provinces into six groups: the four municipalities group (Beijing, Tianjin, Shanghai, and Chongqing); the five coastal provinces group (Jiangsu, Zhejiang, Fujian, Shandong, and Guangdong); the agricultural group (Anhui, Jiangxi, Henan, Hubei, Hunan, Hebei, and Hainan); the industrial group (Liaoning, Jilin, Heilongjiang, Neimenggu, and Shanxi); the northwestern provinces group (Ningxia, Gansu, Shaanxi, Xinjiang, and Qinghai); and the southwestern provinces group (Sichuan, Guizhou, Yunnan, Xizang, and Guangxi). The

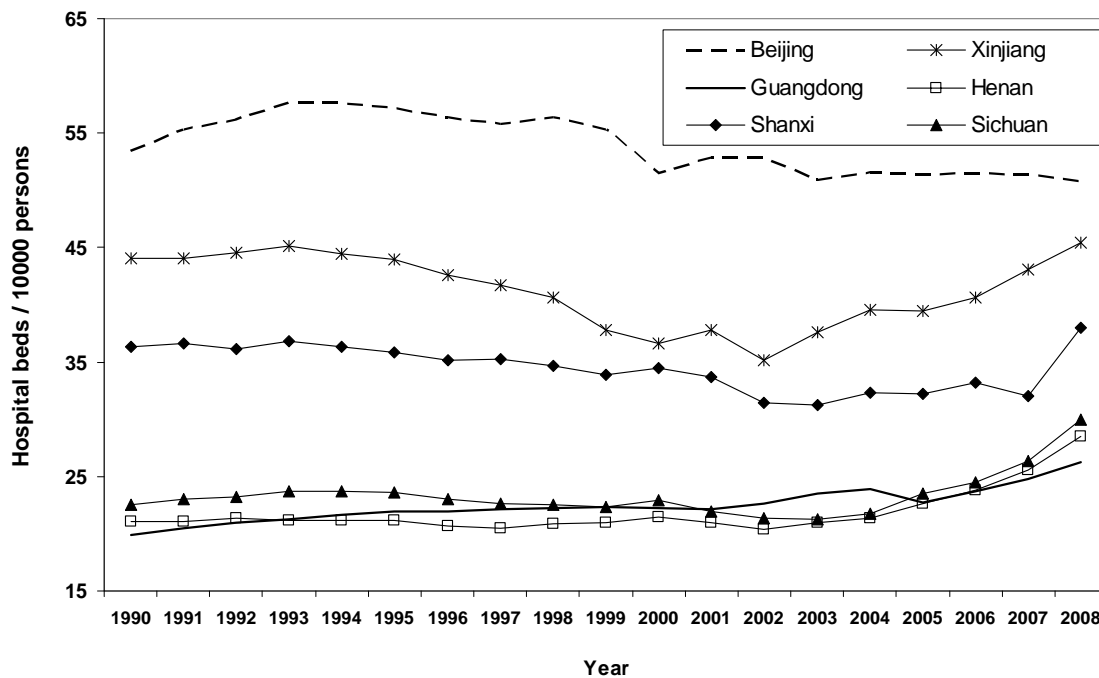


Figure 3. 4 Health care level (number of hospital beds per 10,000 persons) of six provinces, 1990 to 2008.

six provinces represented in Fig. 3.4 were selected from each of these groups, Beijing, Guangdong, Henan, Shanxi, Xinjiang, and Sichuan.

Beijing and two other coastal municipalities, Shanghai and Tianjin, had the highest level of health care due to their advanced initial conditions and advantages conferred by special policies from the central government; however, they all showed overall downward patterns. Chongqing, as a newly upgraded municipality in the western region, lagged far behind although its health care has been significantly improved due to the preferential policies for both the western region and municipalities. The coastal provinces have benefited most from the economic reform and the top five most developed provinces are all located there. Unlike the spectacular economic growth of these provinces, their health care has remained at a relatively low level but has improved steadily. Guangdong, which generated the highest annual GDP among the provinces in the last 20 years, had a health care level similar to that of the western province Sichuan and the agricultural province Henan (Fig. 3.4). Decentralization and marketization of the healthcare sector in some sense impeded the development of health care in the agricultural group where over 70% of residents live in rural areas. Their health care declined in the early 2000s; however, it rose back in the last few years since the government has increased its investment in rural healthcare by implementing the new Cooperative Medical Systems. The health care level of the industrial group (represented by Shanxi) tends to occupy an intermediate position, lagging behind only the four municipalities and the northwestern provinces groups. These provinces were favored by Mao's industrialization policies which promoted the establishment of a series of large-scale state-owned enterprises and supporting public facilities, including clinics and

hospitals. However, their health care levels decreased significantly as the central government switched the focus to the coastal provinces. The western region has attracted more investment, because of the “Western Development Program” (xibu da kaifa). Health care levels in the west have enhanced rapidly, with the number of health institution beds per 10,000 persons increasing from 25.9 in 1990 to 31.4 in 2008. The western region has narrowed the gap it has had with the eastern and central regions.

Analysis of individual provinces has shown that the health care levels are not always consistent with economic development. The health care levels of the five prosperous coastal provinces were all below the national average between 1990 and 2000. In contrast, the five northwestern provinces and the five industrial provinces, despite their economic difficulties, have better health care. The inconsistency reflects one important phenomenon, that is, the health system and economic system have performed differently although the medical system has always been an appendage of the economic system in China. Before the reforms, the health care system had been improving dramatically compared to people’s poor living conditions and the stagnant national economic development. However, the health care reform has lagged behind the economic reform. In recent years, health care has become one of the big issues that the Chinese government urgently needs to address. Apparently, it cannot make the health care system meet the people’s demands by simply bundling it and the economic system together (Xiong, 2008).

Health care tends to be more spatially uneven although the overall inequality has decreased (Fig. 3.5). Moran’s I reveals the spatial concentration of health care among the provinces. An increasing global Moran’s I indicates that the spatial distribution of health

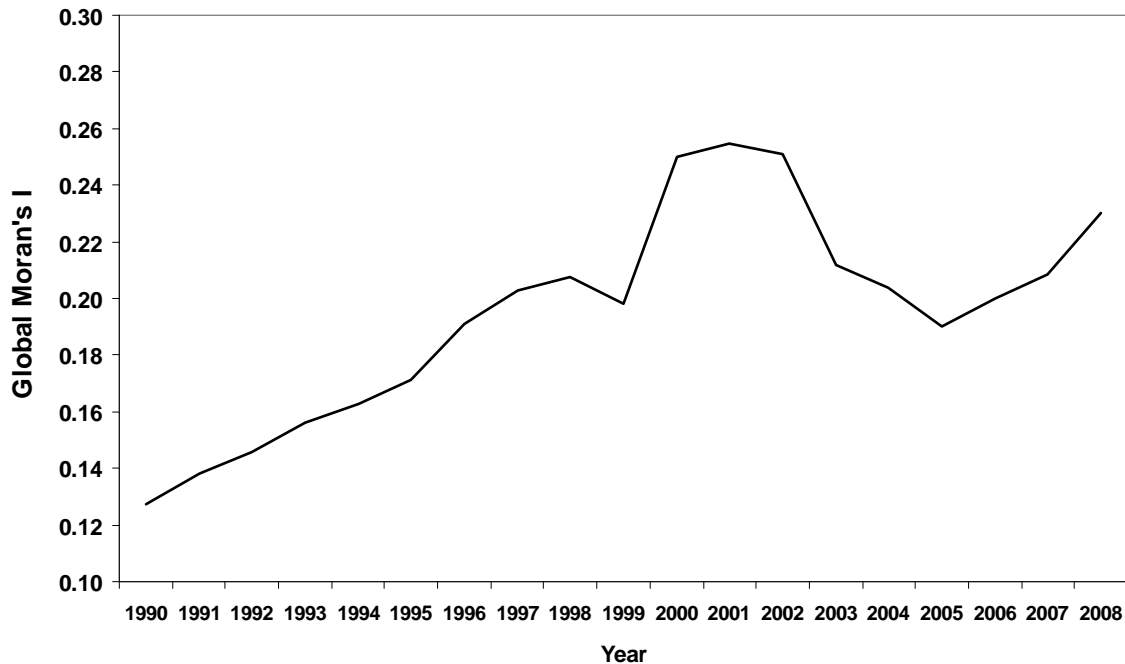


Figure 3. 5 Spatial autocorrelation of health care levels (number of hospital beds per 10,000 persons) among provinces, 1990 to 2008.

care has become more uneven; and decreasing values mean the absolute gap of health care between regions is narrowed and spatial clusters are disappearing. In contrast to the interprovincial inequality (CV), Moran's I shows a generally upward trend of spatial autocorrelation, especially during 1990. After a sharp decline from 2001 to 2005, Moran's I went up again from 2006 to 2008. The spatial investigation demonstrates that spatial association/heterogeneity heavily influences regional inequality in health care.

Unlike the coastal-interior disparity of regional economic development, the north-south gap dominated the spatial pattern of China's health care (Figs. 3.6 and 3.7). In 1990, the coastal municipalities and a few other provinces had relatively high health care levels, scattering across north and central China (Fig. 3.7a). In 2008, the provinces which had greatly improved their health care were gathered in the coastal area around the

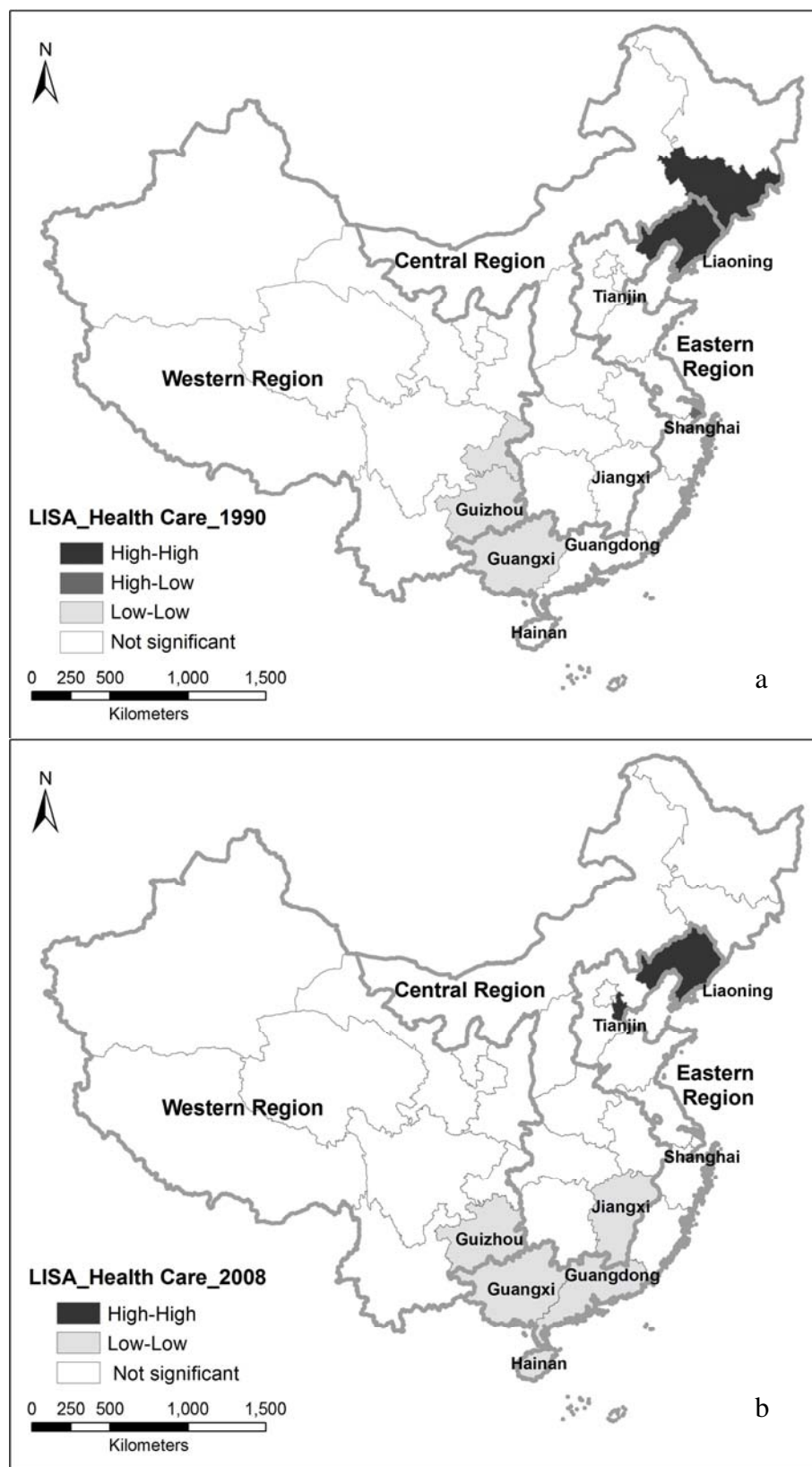


Figure 3. 6 Local spatial patterns (LISA) of health care in 1990 (a) and 2008 (b).

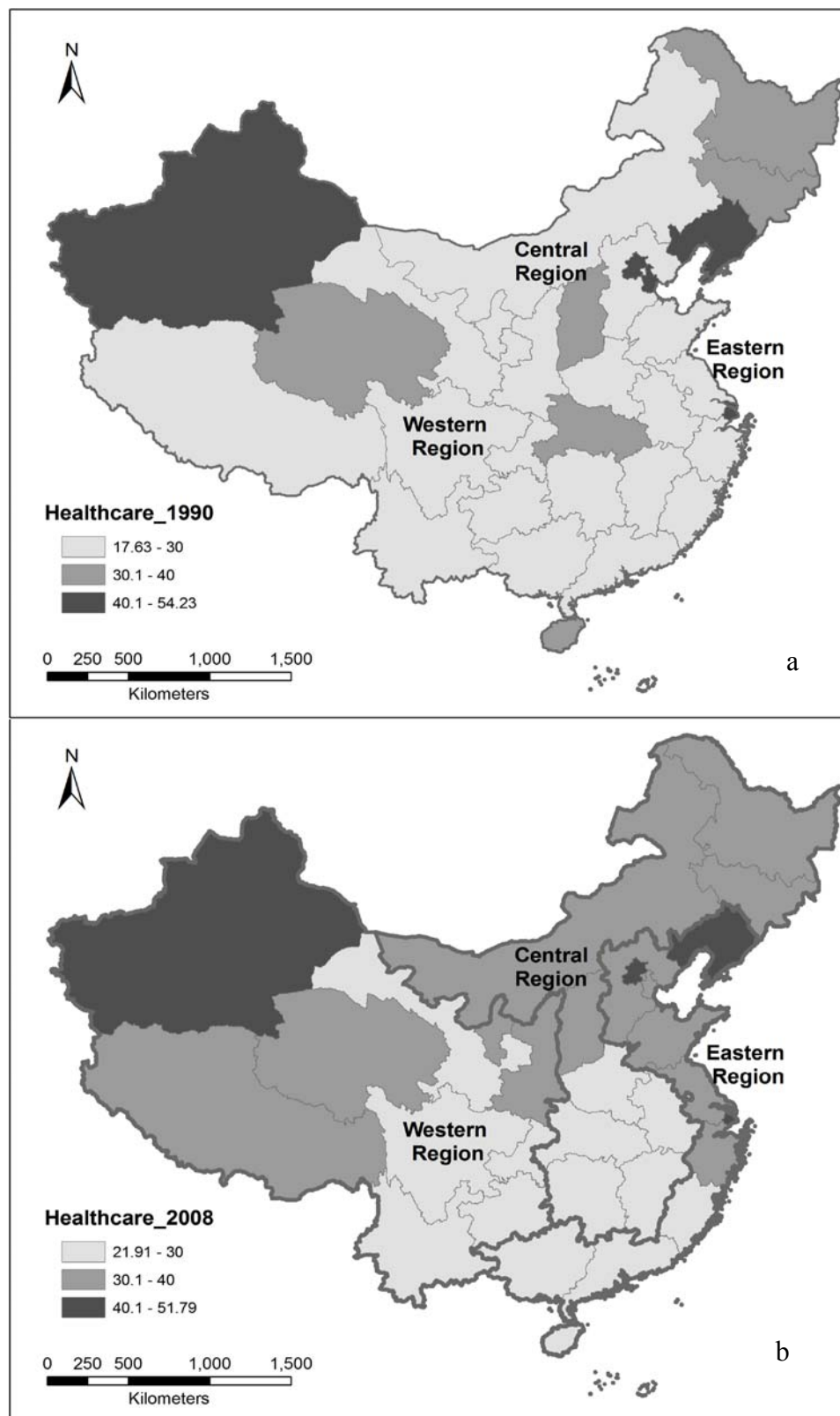


Figure 3. 7 Health care levels (number of hospital beds per 10,000 persons) of the provinces in 1990 (a) and 2008 (b).

municipalities, the northeastern, and the northwestern regions. The municipalities and industrial provinces have played a crucial role in shaping China's health care inequality and their contributions on the global spatial autocorrelation changed after the health care reform. With the rise of nearby coastal provinces, Shanghai's negative contribution to the global index disappeared. Tianjin became major positive contributors, forming a high-high cluster near Bohai Bay along with the industrial province of Liaoning. The influence of Jilin, another industrial province, declined. After upgraded as a municipality, Chongqing separated from the low-low cluster in the southwestern area, while Guangdong, Hainan and Jiangxi joined with Guizhou and Guangxi making this cluster move southeastward. The early works lack spatial analysis so they may not reveal the complexity of health care inequality (e.g., Zhang and Kanber, 2005).

Economic transition, health care, and mortality

Scholars have argued that China's reforms, initiated in 1978 and gathering momentum into the present, have caused fundamental changes in health care and generated a major effect on public health (Zhao, 2006). An improved quality of health care and living conditions have contributed to a dramatic decrease of mortality across the country (Fig. 3.8).¹⁴ Spatial disparities in mortality over the period 1990–2008 changed from a region-focused to a policy-oriented pattern (Fig. 3.9). In 1990, mortality could be described as exhibiting a “three-ladders” pattern, with low values in the eastern region, intermediate in the central, and high in the west, in accord with the respective levels of economic development attained by these regions in the early postreform period. In 2008,

¹⁴The slight uptick in mortality in 2008 is an anomaly, and reflects an unusually high number of deaths due to natural disasters, such as earthquakes in Sichuan and Qinghai, and landslides in Hubei and Hunan.

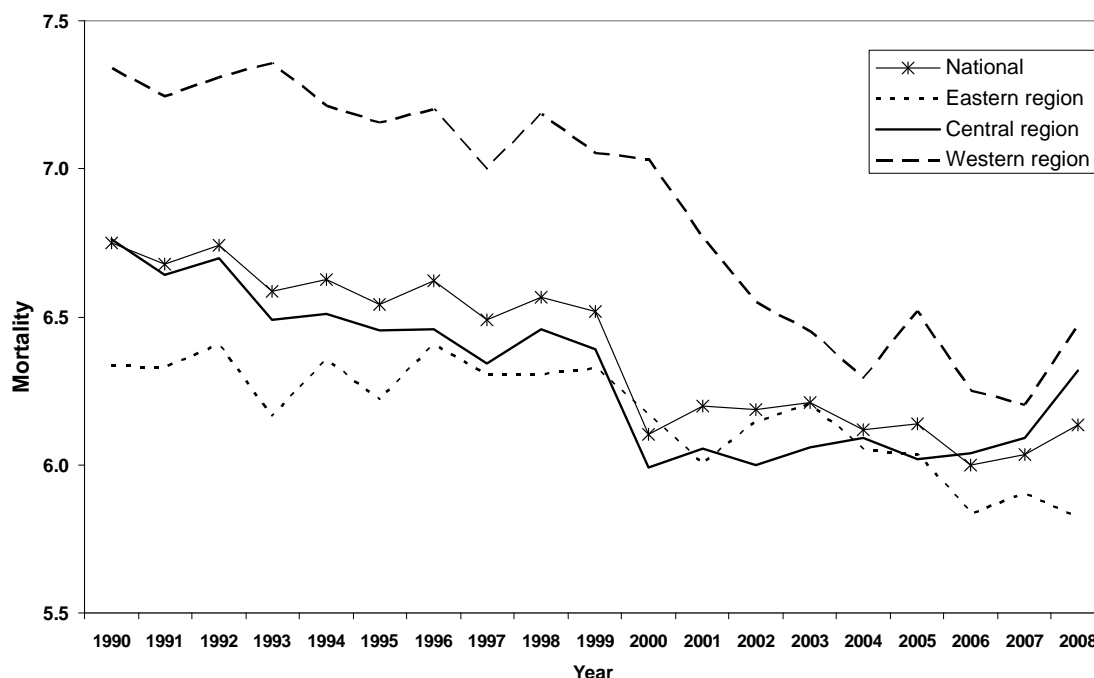


Figure 3. 8 Mortality rate of China from 1990 to 2008.

mortality in the western region declined significantly as a result of increased central government financial support for health care; consequently, the gap between it and the central and eastern regions has been reduced. Moreover, a new high-mortality cluster has emerged in the central region, which has been bypassed to some extent by national development strategies. Consequently, as a result of recent advances in health care reform, the pattern of mortality has become less consistent with that of regional economic development.

Model One and Model Two explain the relationship between mortality, health care, and economic transition in China. Considering the potential problem of multicollinearity, variance inflation factors (VIF) of two models was examined with SAS. According to one rule of thumb, multicollinearity exists if the largest VIF is over 10

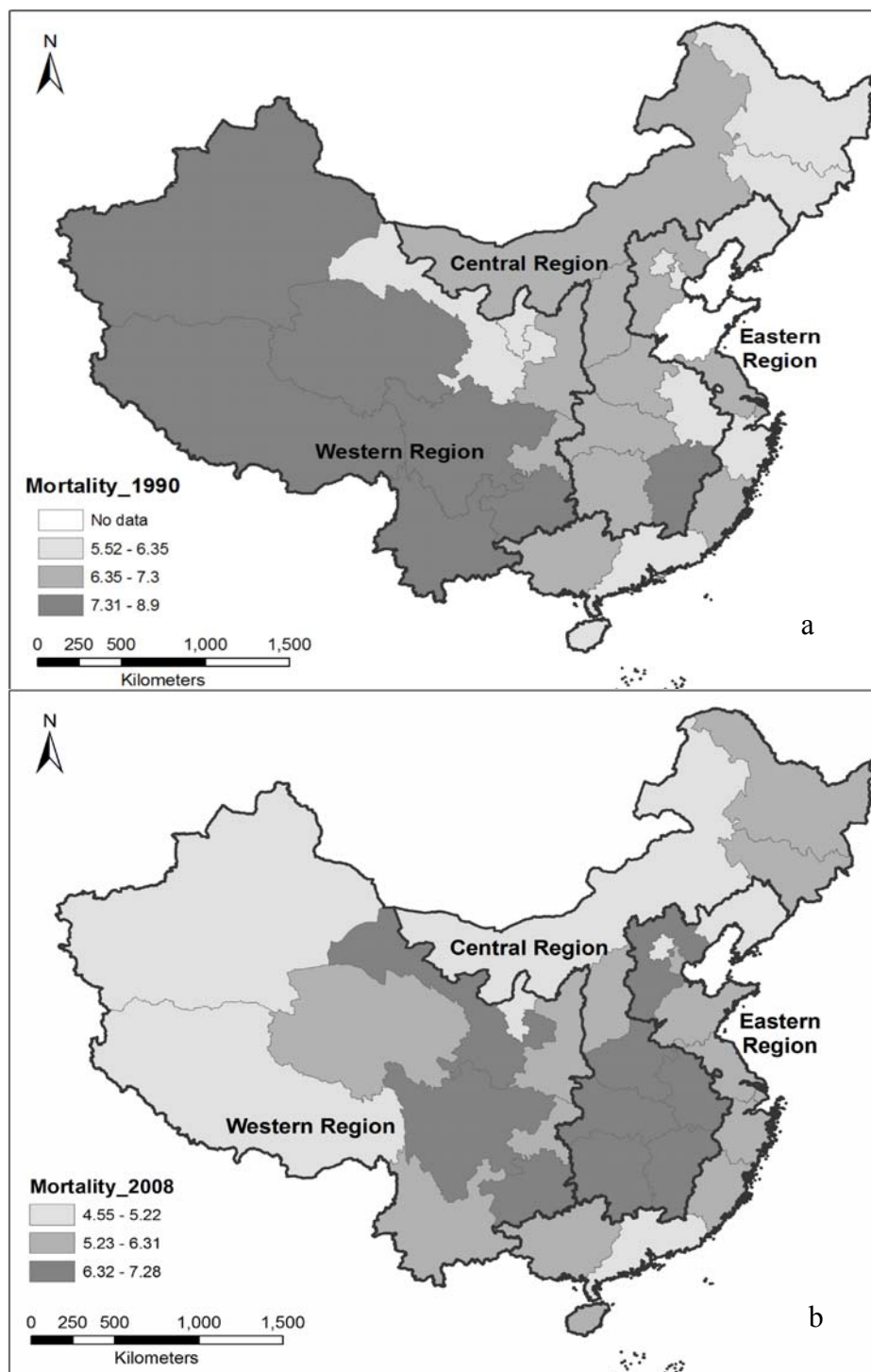


Figure 3. 9 Provincial mortality rates of China in 1990 (a) and 2008 (b).

(Chatterjee et al., 2000; Wen et al., 2003). Therefore, we dropped three variables with VIF higher than or equal to 10, GDPPC (VIF=30, 29), FAIPC (VIF=10, 10), and TRAN (VIF=10, 11). Thus, there are 11 independent variables in Model One and 10 in Model Two, and the largest VIF is less than 5 in both models. We also fit the best models for regression with the significant variables identified in the full models and run multilevel regression based on the best models. The results are summarized in Tables 3.3 and 3.4. Since multilevel modeling can avoid overestimating the statistical significance of regression coefficients, the independent variables were analyzed according to the coefficients and p values of multilevel models.

The regression results reveal the following four findings. First, the variation of health care under economic transition is a key factor for explaining the relationship between health inequality and economic inequality, especially their emerging inconsistency. Model One (Table 3.3) demonstrates the association between health care and mortality ($p < 0.01$), indicating better health care leading to better health outcome. Model Two (Table 3.4) reflects that China's economic transition plays a decisive role in shaping the pattern of health care inequality due to the dependency of the health care system on the economic system. The variables indicating decentralization, marketization, urbanization, and globalization can explain 48.9% of health care variation ($R^2 = 0.489$). R^2 slightly decreases to 0.482 in the best model. Combined with the results of spatial analysis on health care and mortality (Figs. 3.7 and 3.9), it appears that the government's policy intervention has caused the difference in status between health care and economic development in some provinces, which further changed the pattern of mortality inequality.

Table 3. 3 Regression results of Model 1.

Independent variable	Single-level (Province)		Multilevel (Time, region, province)	
	Full model	Best model	Best model	
	Coefficient	Coefficient	Coefficient	
Health care	-0.02 **	-0.02 **	-0.02 **	
FINEXP	-0.01 **	-0.01 ***	-0.01 ***	
POPDEN	0.001 ***	0.001 ***	0.001 ***	
WRD	0.5 ***	0.57 ***	0.57 ***	
FDIPC	0.001			
SOE	0.38			
MI	1.79			
CD	-0.15			
EDU	0.002			
INNO	-0.03			
POPGR	-0.02			
Dependent variable	Mortality			
R-square	0.184	0.162	Likelihood ratio test	1

* $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$ (two-tailed test)

Second, the aforementioned “multimechanisms of transition” have clear relevance to an analysis of health and health care inequality in China. *Decentralization* has been the most important structural change in the health care market following the economic reforms (Akin et al., 2005). Adequate local budget expenditure (FINEXP) has brought high health care levels ($p < 0.001$) and low mortality ($p < 0.01$). *Urbanization* is a double-edged sword in terms of enhancing health (Kent and Haub, 2005). On one hand, migrants from rural to urban areas have accelerated the urban economy as well as health care development (MI, $p < 0.001$). On the other hand, urban health care has been overwhelmed by a rapidly growing urban population density (POPDEN, $p < 0.001$, Model Two), contributing to elevated mortality (POPDEN, $p < 0.001$, Model One).¹⁵

¹⁵Public services and natural resources cannot accommodate the vast number of immigrants, with uncontrolled population growth in urban areas contributing to heightened morbidity and mortality.

Table 3. 4 Regression results of Model 2.

Independent variable	Single-level (province)		Multilevel (time, region, province)	
	Full model	Best model	Best model	
	Coefficient	Coefficient	Coefficient	
FINEXP	0.2 ***	0.18 ***	0.28 ***	
POPDEN	-0.004 **	-0.004 **	-0.007 ***	
MI	49.6 ***	47.4 ***	52.9 ***	
FDIPC	0.03 ***	0.03 ***	0.02 ***	
INNO	1.98 ***	1.89 ***	3.9 ***	
SOE	1.67			
CD	-0.2			
WRD	-1.79			
EDU	0.01			
POPGR	0.08			
Dependent variable	Health care			
R-square	0.489	0.482	Likelihood ratio test	< 0.0001

* $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$ (two-tailed test)

Two other mechanisms, *globalization* and *marketization*, have had a relatively weak influence. The former is positively related to health care levels (FDIPC, $p < 0.0001$), but only because FDI largely determines and reflects local economic growth. The latter (SOE and EDU) is not significant to either mortality or health care levels. Globalization and marketization of the health care sector remain far behind many other sectors of the fund (INNO, $p < 0.001$), which is also conducive to health care improvement. The two dummy locational variables (CD and WRD) barely contribute in two models (WRD to mortality, $p < 0.001$), illustrating the reduced regional gap in mortality and health care. The control variable, population growth rate (POPGR), is not significant in either model.

Third, the distribution of health care reflects the spatial-temporal hierarchy. Table 3.4 compares the results of single- and three-level versions of Model Two. According to likelihood ratio test ($p < 0.0001$), the explanatory power of the three-level model is

greatly enhanced by the addition of the region and time levels.¹⁶ This result indicates that the spatial-temporal hierarchy increases the reliability of the multimechanism framework for analysis of regional inequality in the economy (Li and Wei, 2010) and in such social sectors as health care. The previous literature rarely uses both the spatial and temporal dimensions to explore causation of health and health care inequality. Zhao (2006) conducted a cross-sectional study without analyzing the process, and therefore ignored the positive effect of socioeconomic transformations on reducing income and health inequalities. Chou and Wang (2009) introduced a temporal dimension to investigate the relationship between health care expenditure and income inequality, but neglected the spatial hierarchy of data and thus may have overlooked some features shaping the country's social and economic development.

Fourth, these macro-level variables account for a partial variation of mortality because micro- and individual-level components are also involved to determine health conditions. 18% and 16% of changes of mortality can be explained by the 11 variables in the full model ($R = 0.18$) and 4 variables in the best model ($R = 0.16$) of Model One, respectively. We also tried to add other macro-level variables such as urban unemployed rate, average wage, and ratio of household living expenditure to income; however, the results changed only slightly. Based on the literature review, micro- and individual-level factors contribute largely to mortality, including genetic, psychological, material, and environmental conditions. Future research focusing on some of these factors would complement the present study.

¹⁶Unlike mortality (Table 3.3), health care data have a hierarchical structure that is sensitive to the spatial and temporal hierarchy of the four multimechanisms.

Conclusion

This research investigates the economic transitions, health care, and mortality in China during the reform era from a geographical perspective to enrich the literature on health inequality. First, it examines health care inequalities at multiple spatial scales. It was found that health care inequalities are sensitive to spatial scales, and the disparity is larger at finer spatial scales. The highly unbalanced medical service among counties reflects not only the urban-rural gaps within the same region but also rural-rural differences among regions. The interregion, interprovince, intraregion, and intercounty inequalities all declined from 1990 to 2008; however, the spatial concentration has increased and gradually formed north-south segmentation. The provinces with better health care mainly agglomerated around the coastal municipalities, industrial provinces, and minority provinces in northwestern area.

Second, this research emphasizes the role of health care for explaining the association between mortality and economic inequality with the hierarchical regression approach. The findings suggest that both mortality and regional health inequality decreased with increasingly better living conditions and health care redistribution through the economic transition. We also detected the different effects of multimechanisms on health and health care. Decentralization and urbanization are decisive mechanisms reshaping spatial patterns of health and health care, the flow of capital and labor guided by the central government determining both economic and social inequality. In this process, globalization and marketization have little influence since state-owned medical service still dominates in the health care sector after three decades of reform.

Third, these findings have the following theoretical and policy implications. The results demonstrate the theoretical framework of multiscale and multimechanisms can be used to verify the causal linkage between health care, health, and economic inequality. This is a step forward compared to that research only testing the hypothesis of health and income inequality without regarding the intermediate factors (e.g., Li and Zhu, 2006; Pei and Rodriguez, 2009). From the policy view, China's major development strategies focus on the eastern and western regions while they ignore the central provinces to some extent. The decline of the central region has become a new issue which needs more attention from policy makers. In addition, the increasing intercounty health care inequality within each region indicates the problems of micro-level operation although the national disparity has been decreased by macro-control and resource allocation. Under the supervision of the central government, the local governments should make more efforts to balance the health care investment between rural and urban areas, and among counties.

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CHAPTER 4

CORE-PERIPHERY INEQUALITY IN PROVINCIAL CHINA: A CASE STUDY OF HENAN PROVINCE

Abstract

This paper investigates the economic and social inequalities in an agriculture-oriented province of China, Henan Province. There are two objectives: (1) this research analyzes the economic inequality at multiple spatial scales from 1993 to 2008 and examines the influence of China's transitions on the economic development; (2) this study explores the spatial distribution of health care level and the relationship between health care, economic development, and economic transitions. The GIS-based spatial statistical methods, Getis-Ord G_i^* and Geographically Weighted Regression, are applied to detect the spatial-temporal variation of social economic unevenness and analyze the underlying driving forces. The results illustrate that the core-periphery disparity has been further enlarged in both economic and social development. The spatial nonstationarity in development mechanisms plays an important role in shaping Henan's regional inequality patterns.

Introduction

After 30 years of dramatic economic growth, China has surpassed Japan and become the second largest economy of the world in 2010. However, the economic transitions such as decentralization, marketization, globalization, and urbanization have also generated negative ramifications. In particular, regional economic and social inequalities in China have caused increasing concerns from both policy makers and the public. The central government has listed “reducing regional disparity” as one of the most important goals in Five-Year Plans since 1996. Chinese people also become more dissatisfied about welfare disparities in medical care, education, etc.

Regional inequality has been a topic of intense debates among convergence and divergence since the 1950s. During the 1990s, academic discussion had been fueled over the research advantages in new convergence and new economic geography (e.g., Barro & Sala-I-Martin, 1995; Krugman, 1995). Barro and Sala-I-Martin (1991, 1992) proposed a new explanation on convergence indicating that poorer regions grow faster than richer regions, while the absolute gap may not definitely decrease over time. Recently, new economic geography (NEG) has become a mainstream concern, because regional inequalities are always associated with location. Krugman and Venables (1995) developed a core-periphery model for understanding how the centripetal forces pull economic activity together and the centrifugal forces push it apart, and how these two forces shape the geographical structure of an economy under the globalization background.

Scholars have identified the typical core-periphery spatial pattern of China’s regional development (Cao, 2009; Zhang & Kanbur, 2005), reflected by two-dimensions

of societal polarization, coastal-inland and urban-rural gaps. In the early stage of the reform, the central government was prone to develop the coastal region and encouraged this region to “get rich quick” (Wei, 1999). Consequently, literature tended to study the coastal provinces and to explore the coastal-inland inequality (e.g., Chen, 2010; Fan, 1995; Li & Wei, 2010a). As the policy focus switches to some interior provinces, the coastal-inland disparity has been slightly narrowed; however, the urban-rural inequality has become more prominent even though the government accelerates the urbanization process to reduce urban-rural difference, whereas only a few studies shed light on the interior provinces and examines China’s regional inequality with the emphasis of urban-rural dimension (e.g., Cao, 2009; Kanber & Zhang, 1999).

China’s reform is an uneven process, with various layers to the transition. The phenomenal economic growth and profound social change have been accompanied by serious social issues. Besides the economic level, well-being is another important measurement of human development, and the different quality of and accessibility to basic social resources is among the key reasons causing the polarized society (Keidel, 2009). Scholars have attempted to describe and explain the social inequalities, for example, education (Cao, 2008; Qian & Smyth, 2008; Wu, 2008), gender (Cai & Wu, 2006; Shu et al., 2007), and health (Chou & Wang, 2009; Zhao, 2006). Nonetheless, the literature has overwhelmingly linked regional inequality to economy, neglecting the influence of social inequality as both a cause and a consequence of regional economic disparities (Cao, 2008; Li & Wei, 2010b).

This paper builds on two recent trends of studying China’s regional inequality. First, related research has shown complex landscapes and the latest studies tend to

explore the intraprovince disparity (Wei & Ye, 2009). Scholars have reached consistent conclusions that the reform has intensified the core-periphery gap within coastal provinces (Lu & Wei, 2007). Example studies include the difference between Pearl River Delta and other areas in Guangdong Province resulting from the uneven foreign investment (Lu & Wei, 2007), the change from urban-rural gap to north-south divide in Beijing during the reform (Yu & Wei, 2008), and coastal-interior inequality in Zhejiang Province because of the distribution of private enterprises (Wei & Ye, 2009). With the launch of the “Western Development Program” (xibu da kaifa), research on western provinces enriches the literature (Cao, 2010; Xing, 2009). For instance, Cao (2009) demonstrated that the Xinjiang Uygur Autonomous Region has been experiencing growing urban-rural disparity due to the spatial segmentation between ethnic minorities and majorities. However, the central agriculture-oriented provinces have been ignored by both scholars and policy-makers to some extent, although they are the home of over 1/3 of the total Chinese population.

Second, health care has been a burning topic in both developed and developing countries; however, the study of China’s health care inequality still remains limited (Li & Wei, 2010b). Scholars have examined health care inequality and the underlying factors (e.g., Eggleston et al., 2008; Li & Wei, 2010b; Wang et al., 2009; Zhan, 2005). Zhang and Kanber (2005) documented the increasing trend of urban-rural disparity but decreasing trajectory of interprovince inequality in health care. The study of Wang et al. (2009) has proposed that the high cost and inequality in health care was caused by inadequate government investment as well as weak supervision and administration in the past two decades. Li and Wei (2010b) have provided a multiscale and multimechanism

investigation and noticed the rising spatial concentration of health care during the reform era. They have also demonstrated that health care inequality is a major factor for explaining the linkage between health outcomes and economic inequality. These national-level studies outline China's health care variation; and a deep investigation on a certain province would provide a new angle to better understand China's social unevenness.

This paper utilizes GIS and spatial statistic methods to examine economic and social inequalities in a central agriculture-oriented province, Henan Province. This study intends to achieve two objectives. First, we analyze the spatial-temporal variation of economic inequality at prefecture and county levels from 1993 to 2008 by highlighting the urban-rural gap. This research also examines the influence of China's multiple transitions on the development process of this agricultural province. Second, health care inequality in Henan Province is analyzed as a consequence of economic transitions. We explore the spatial distribution of health care level, and the relationship among health care, economic development, and multiple transitions behind the varying spatial pattern. The next section discusses data and methodology. After that, we examine the economic disparity and health care inequality. Finally, we conclude with major findings.

Data and Methodology

Study area

Henan Province (hereafter Henan), located in the central region of China, has 18 prefecture-level (hereafter city) and 159 county-level administrative units (Fig. 4.1). The latter includes 108 counties (*Xian*) and 51 districts (*Qu*). Districts are mostly urban areas

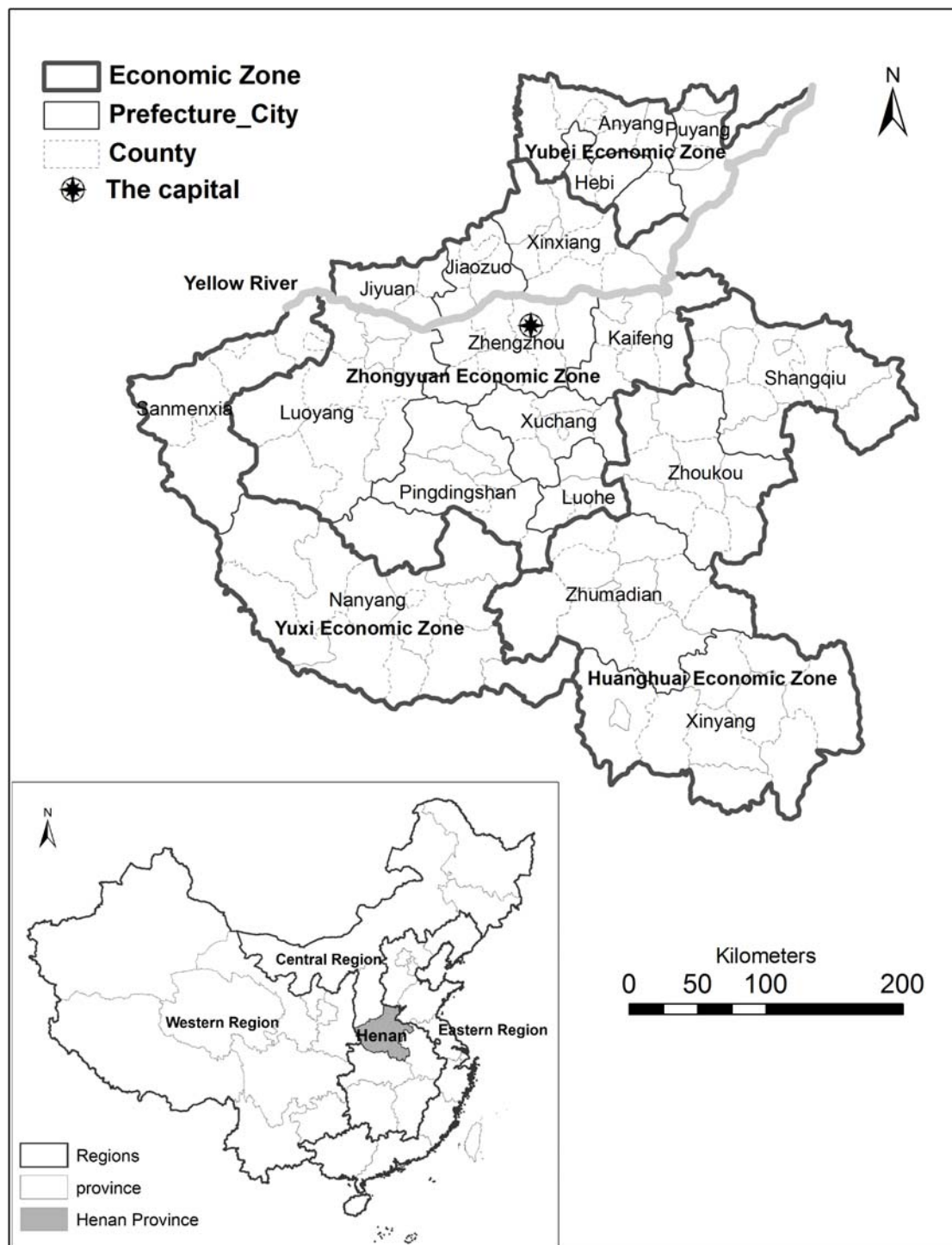


Figure 4. 1 Henan Province

while rural residents usually are the majority in counties. Based on the geographical and historical factors, this province has been divided into four Economic Zones, namely, Zhongyuan, Yubei, Yuxi, and Huanghuai. Henan had a population of 99.2 million (7.5% of China's total population) and 167,000 square kilometers (1.74% of China's territory) in 2008 (Henan Statistic Year Book). Henan has special historical, geographic, social, and economic characteristics, and has been called the "Central State" (*zhongzhou*) or "Central Land" (*zhongyuan*), indicating its importance in ancient China. This province was the origin of Chinese civilization and culture, and contains three famous ancient capital cities, Luoyang, Kaifeng, and Anyang. Traditional culture has a strong hold on the people and many are unwilling to accept new concepts and changes. Henan is also a classic agricultural province and the rural population accounts for over 75% of the total population in 2005. Conservative thoughts and the lagging industrial structure led to relatively slow reform process in this area. At the same time, Henan is the most populous province in China. The rapid population growth (from 70.67 million in 1978 to 99.2 million in 2008; Henan Statistic Year Books) and limited resources per capita have brought a series of social problems. For example, rural poverty and low level of health care have resulted in the existence of "AIDS Villages." In addition, Henan serves as a major transportation hub and economic junction linking eastern and western regions and northern and southern China.

Data

Data acquired in this paper include socioeconomic and health data as well as GIS shapefiles. Henan Statistic Year Book and China Data Online (<http://chinadataonline.org>)

provide prefecture-level socioeconomic and health data from 1993 to 2008 and county-level data from 1997 to 2008. Two commonly used measurements, GDP per capita and the number of hospital beds per 10,000 persons, are selected to indicate economic development and health care level, respectively. The independent variables for explaining economic and social inequalities are: local budget expenditure (FINEXP), the percentage of employees in non-state-owned enterprises (NONSOE), foreign direct investment (FDI), the percentage of urban population (URBANIZATION), and distance to Zhengzhou (DISTANCE). GIS shapefiles are downloaded from the China Data Center (<http://chinadatacenter.org>).

Methods

Coefficient of variation (hereafter CV), a popular measurement of inequality, is applied to examine the temporal variation of inequalities in economic development and health care level. This statistical method is defined as the ratio of the standard deviation to the mean. We also use the Getis-Ord G_i^* statistic to detect spatial agglomeration among counties because the CV only reveals the overall inequality but has limitations when it comes to analyzing spatial inequality. This statistic, developed by Getis and Ord (1992), measures the spatial concentration of features with high values or low values based on the weighted points. The degree of clustering is determined by the difference between the statistic's expectation and the proportion of the summed variable within a specific distance from the original weighted point to the entire summed variable. The concentration is reflected by Z score of each feature in the dataset. For statistically significant Z scores (≥ 1.96 or ≤ -1.96), the larger positive Z scores indicate more

intense clustering of high values, while the smaller negative Z score represents the concentration of low values.

The mechanisms behind the economic and social inequalities are examined by Geographically Weighted Regression (hereafter GWR). Unlike physical processes, social processes appear to be *nonstationary*, which means the measurement of a relationship depends partially on where the measurement is taken. The traditional stationary and nonspatial regression model is unable to efficiently explain the spatial variation of regional inequality because it assumes the relationship under study is constant over space. GWR has been developed to deal with the nonstationary data by allowing regression model parameters to change over space (Fotheringham et al., 2001, 2002). In order to represent a continuous spatial process with a discrete weighting system, a region is described around a regression point. All the data points within this region are weighted by their distances from the regression point. Data points closer to the regression point are weighted more heavily in the local regression than are data points farther away.

A regression model is calibrated locally through a spatial kernel function. Generally, two types of spatial kernel functions are present in the literature, fixed or adaptive spatial kernel functions (Yu, 2006). In the former approach, one optimum spatial bandwidth is applied in the entire study area which might overestimate the degree of nonstationarity in areas where data are sparse and understate that where data are dense (Fotheringham et al., 2002; Paez et al., 2002). Therefore, we choose the adaptive spatial kernel function in this study. This approach is capable of adjusting the kernel sizes based on the density of the data by adopting larger bandwidths where the data are sparse and smaller ones where the data are dense. A nearest neighbor method is used to produce the

adaptive spatial kernels through minimizing the goodness-of-fit statistics, namely the Akaike Information Criterion (AICc) (Fotheringham et al., 2002; Hurvich et al., 1998; Yu, 2006). We use the spatial statistic tool in ArcGIS 9.3 to conduct GWR analysis.

According to recent applications of GWR on China's development (Wei & Ye, 2009; Yu, 2006), two regression models are specified: The Model One explores how Henan's economic inequality has been shaped during China's reform and transitions. The dependent variable is GDP per capita. According to the recent literature (Li & Wei, 2010a; Wei & Ye, 2009; Yu & Wei, 2003), five independent variables are selected: (1) Foreign direct investment indicates the force of globalization. Since more than half of districts/counties had little FDI during the study period, we convert FDI to a dummy variable. The ones with FDI are defined as 1 and the others 0. (2) Percentage of employees in non-state-owned enterprises reflects the level of marketization. (3) Decentralization is represented by per capita local budget expenditure, showing the power decentralized from the central government to the local government. (4) Urbanization is proxied by the percentage of urban population. And (5) distance to the capital, Zhengzhou City, indicates the influence of the growth pole.

Model Two examines whether economic inequality and multiple transitions have changed the spatial distribution of health care level in Henan Province. The dependent variable is the number of hospital beds per 10,000 persons. The independent variables include the aforementioned ones in Model One as well as GDP per capita reflecting the economic development level.

Given the characteristics of GWR, its most valuable advantage for explaining China's multiple transitions is not to distinguish the significant mechanisms but to reveal

the spatially varying effect of each mechanism on local economic social development. Therefore, different from the literature (e.g., Wei & Ye, 2009; Yu, 2006), we calculate the local p-values of each coefficient instead of global ones for deeply understanding China's transitions.

Regional Economic Inequality in Henan Province

Henan has gained incredible economic growth since 2000. In 2008, Henan produced 1423.4 billion Yuan of GDP and was the only interior province among the top five. However, Henan ranked 16th among 31 provinces in terms of per capital GDP. In the last decade, the provincial government has implemented new strategies to encourage Henan to transform from a traditional agriculture province to a pluralistic economy. First, the provincial government proposed industrialization, urbanization, and agricultural modernization as the driving forces of economic growth. The local governments urge economic restructuring and industrial upgrading by establishing industrial agglomeration zones which has further accelerated economic development in surrounding agricultural counties. The large-scale expansion of urban area makes it possible to accommodate a large number of workers migrating from rural area. The percentage of agricultural population decreased from 76.8% in 2000 to 64% in 2008 (Henan Statistic Year Books). The governments also emphasize the transformation of agricultural production and operation as well as encourage industrialization of agriculture.

Second, the rise of Zhongyuan Economic Zone (also called Zhongyuan Urban Agglomeration) has been listed as a major development strategy in Henan's Eleventh Five-Year Plan (2006-2010). This economic zone is constituted of 9 prefecture-level

cities, Zhengzhou (the center), Luoyang (the second center), Kaifeng, Xinxiang, Jiaozuo, Xuchang, Pingdingshan, Luohe, and Jiyuan. Following the national development strategy, Henan provincial government aims to prompt the economic growth in initially advanced area and then to drive the development in other areas especially the rural society. Recently, Zhongyuan Economic Zone has been officially incorporated into the national planning as a transport hub and logistics center; regional innovation and technology center; as well as a service industry, high-tech industry, and raw material base. At the national level, this strategy helps to reduce the gap between the central and coastal regions. However, within Henan Province, this plan tends to exacerbate the core-periphery inequality. These strategies have changed the spatial-temporal trajectory of Henan's economic development.

Spatial-temporal variation of regional economic equality

The CVs of GDP per capita at the prefecture- and county-level are calculated and summarized in Fig. 4.2 and Table 4.1. The CV of prefecture-level inequality increased from 0.37 in 1993 to 0.43 in 2008. It remained flat from 1993 to 1999, then rose till 2005, and declined again from 2006 to 2008. The disparity among all county-level administrative units generally kept stable with some small fluctuations. After separating them into the counties and districts, they showed more complex trends. The CVs of counties increased from 0.53 in 1997 to 0.65 in 2008 while those of districts slightly declined from 0.38 to 0.35 in the same period. Apparently, the rural-rural disparity has been greatly enlarged.

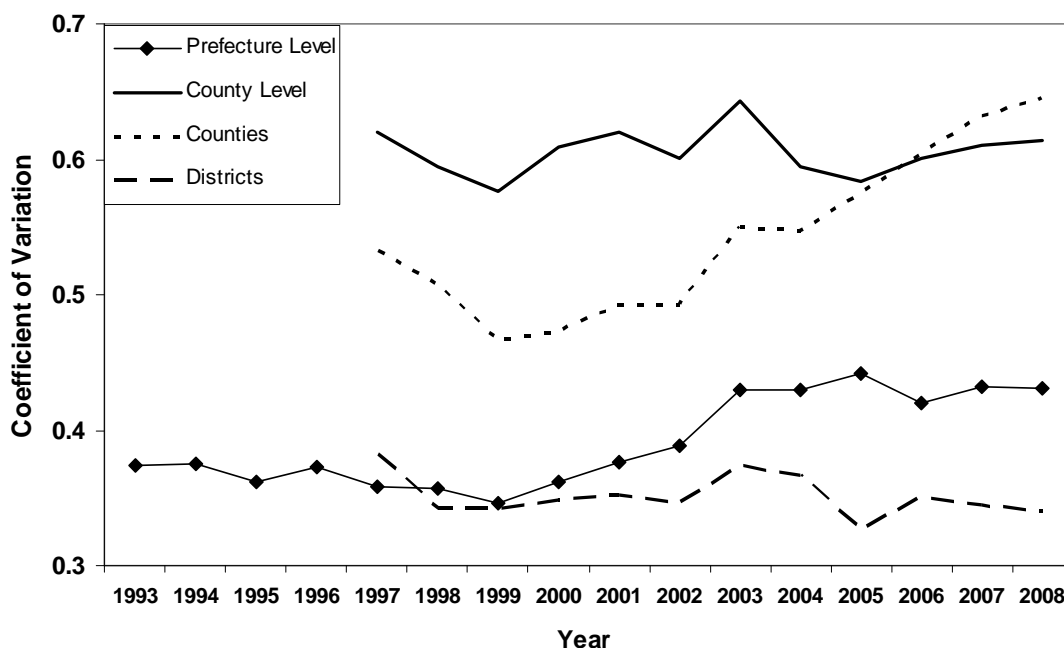


Figure 4. 2 Changes in the coefficient of variations of GDPPC in Henan Province (Intercounty and interprefecture city).

Table 4. 1 Coefficient of variation (CV) of the GDP per capita of Henan Province

Units	1993	1997	2000	2005	2008
Prefecture cities (18)	0.37	0.36	0.36	0.44	0.43
All county-level administrative units (159)	N/A	0.62	0.61	0.58	0.61
Counties w/o Districts (108)	N/A	0.53	0.47	0.58	0.65
Districts (51)	N/A	0.38	0.35	0.33	0.34

Getis-Ord G_i^* is applied to analyze the spatial distribution of wealth in Henan Province. Fig. 4.3 expresses the hotspot analysis of GDP per capita in Henan Province in 1997 and 2008. In 1997, the hotspots ($ZScore \geq 1.96$) scattered in the central and northern areas of Henan Province, including districts of Zhengzhou, Luoyang, Jiaozuo, Puyang, and Anyang, as well as Xinzheng County. The wealth tended to be more concentrated in the core area in 2008. A large cluster has been formed with districts and

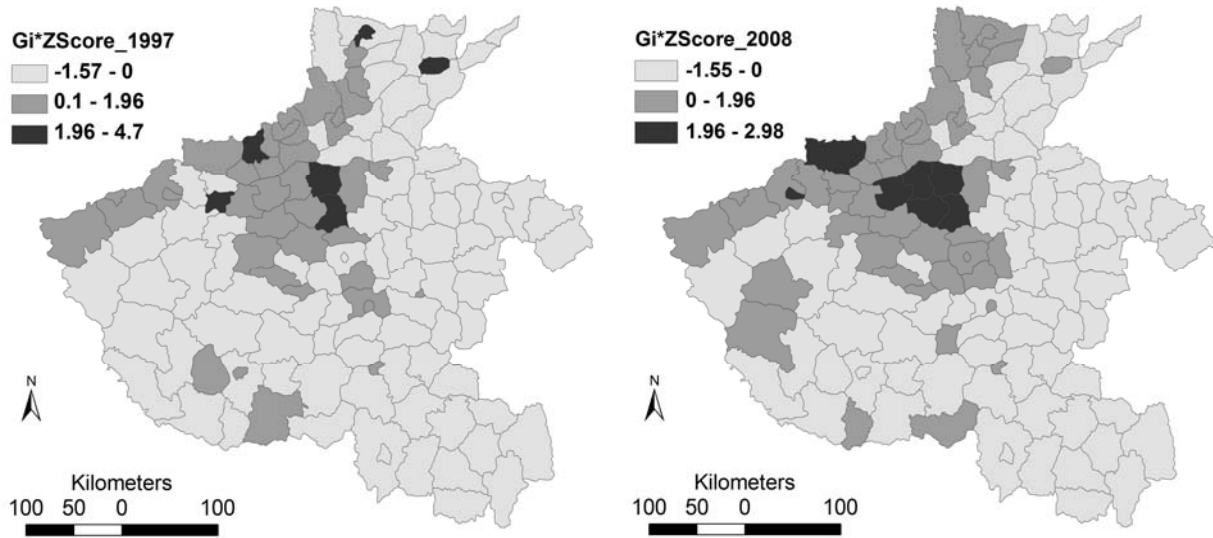


Figure 4.3 Hotspot analysis of GDPPC of Henan Province in 1997 and 2008.

four surrounding counties within Zhengzhou, indicating the rise of a strong growth pole. The second cluster in the core area is located in Jiyuan City, composed of a district and two counties. The only hotspot in the periphery area is Yima County, which is one of the richest counties in Henan benefiting from abundant coal resources.

The results of CV and Getis-Ord G_i^* point to two changes of Henan's economic inequality. First, the urban-rural economic gap has been reduced during the process of urbanization. Urbanization has been proposed as an important approach for accelerating rural development in the Ninth Five-Year Plan (1996-2000) and Tenth Five-Year Plan (2001-2005) of Henan. The provincial government outlined a blueprint of a multilevel urban planning framework composed of the capital (first level), seven important prefecture-level cities (second level, four of them in core area), 20 selected counties (third level), and 115 townships (fourth level). Around them, the urban areas have been expanded to the surrounding rural area and the nearby peasants have become urban

residents. In order to create jobs for these new residents, governments encouraged and supported the development of tertiary industry at the same time, for example, community services. These approaches have balanced urban-rural economic unevenness to some extent. The GDP per capita of districts (*Qu*) was 1.9 times that of counties (*Xian*) in 1997, which decreased to 1.5 times in 2008 (Table 4.2). The urban-rural difference reduced in both the core area (1.9 to 1.3 times) and the periphery area (1.5 to 1.4 times) in the same period of time.

Second, the core-periphery gap has been further widened at both prefecture and county levels. As mentioned above, the rise of Zhongyuan Economic Zone has been set up as the No. 1 goal of Henan Province in the first two decades of 21st century. The provincial government has started implementing “Integration of Zhengzhou and Kaifeng” (*Zheng-Bian Yitihua*) as the first step for achieving the goal. The New Development Zone of Zhengzhou-Kaifeng (*ZhengBian Xinqu*) has been the core growth pole of the entire province. The following step is establishing six new urban areas in Zhengzhou (center), Luoyang (deputy center), Kaifeng (educational base), Xinxiang (satellite city), Xuchang (electric valley), and Jiaozuo (old industrial base). The core area has become more dominated with these policies. The percentage of GDP created by the core area increased from 53.34% in 1993 to 57.14% in 2008 despite the fact this area only accounts for 40% of the total population (Table 4.3). The GDP per capita of the core area was twice that in the periphery area in 2008, which was 1.7 times in 1993. The county-level data express more frequent fluctuations (Fig. 4.2) because the provincial governments upgraded some counties to districts and redrew the administrative divisions of some prefecture cities. These changes have also had effect on the inequality pattern. The urban-urban disparity

Table 4. 2 Comparison between the urban and rural areas in Henan Province.

Region	Area	1997	2000	2005	2008
All	District	7271	8980	16225	24178
	County	3825	4558	9302	15962
Core (Zhongyuan Economic Zone)	District	9498	11242	20785	30732
	County	4891	5761	12749	23032
Periphery	District	4874	6458	11078	16422
	County	3189	3838	7264	11919

Table 4. 3 Comparison between the core (Zhongyuan Economic Zone) and periphery areas in Henan Province.

Indicator	Region	1993	2000	2005	2008
GDP (Billion Yuan) /Percentage	Core	876.5	2683	4758.4	10562.4
	(Zhongyuan Economic Zone)	/53.3%	/52.7	/55.2%	/57.1%
	Periphery	766.9	2403.9	3862.5	7921.6
		/46.7%	/47.3%	/44.8%	/42.9%
POP (Thousand) /Percentage	Core	35660	38080	39290	39915
	(Zhongyuan Economic Zone)	/40.1%	/40.1%	/40.2%	/40.2%
	Periphery	53180	56810	58420	59320
		/59.9%	/59.9%	/59.8%	/59.8%
GDPPC (Yuan)	Core	2458	7046	12110	26462
	(Zhongyuan Economic Zone)				
	Periphery	1442	4231	6611	13354

between core and periphery areas slightly declined while the rural-rural difference sharply rose. The GDP per capita in the core counties was 1.5 times that in the periphery ones in 1997, which increased to 1.9 times in 2008 (Fig. 4.2; Table 4.2).

The mechanisms behind economic inequalities

We conducted two GWR models with 1997 and 2008 datasets compared to the traditional OLS regressions (Tables 4.4 and 4.5). The results of OLS models indicate that 55% and 67% of the variations of GDP per capita can be explained by five selected

Table 4. 4 Global OLS regression results for Model One.

1997				2008			
Dependent variable	GDPPC			Dependent variable	GDPPC		
Independent variable	Coefficient	P-value	VIF	Independent variable	Coefficient	P-value	VIF
Intercept	2179	< 0.001	N/A	Intercept	4680	0.04	N/A
FDIPC	-444	0.63	2.90	FDIPC	5322	< 0.01	1.88
NONSOE	9469	< 0.001	1.02	NONSOE	19472	< 0.001	1.13
FINEXP	0.52	0.33	2.03	FINEXP	8.44	< 0.001	2.58
URB	8394	< 0.001	4.46	URB	-23484	< 0.001	2.51
DISITANCE	0.00	< 0.001	1.03	DISITANCE	-0.03	< 0.001	1.05

Table 4. 5 Comparison between OLS and GWR models (Model One).

Diagnostic Statistics	1997		2008	
	OLS	GWR	OLS	GWR
Multiple R-squared	0.57	0.88	0.68	0.80
Adjusted R-squared	0.55	0.81	0.67	0.74
AICc	2341	2278	2672	2666
Sum of Residual Squares (SRS)	457,794,043	126,433,689	5,840,321,868	3,588,308,840

independent variables in 1997 and 2008, respectively. Among them, three variables, NONSOE, URB, and DISITANCE, are significant at 5% level in 1997, while all five independent variables become influential to GDPPC in 2008.

Different from the global model, it is inappropriate to calculate the global p -value of each coefficient for the local model because the relationship between dependent variable and a certain independent variable varies across space (Furtheringham et al., 2002). To avoid masking the variation, we computed p -values of each spatial unit for the significant variables identified by global models (OLS models) and then map the coefficients with ArcGIS (Figs. 4.4 and 4.5). The spatial units are highlighted in blue where the coefficient is significant at 5% level. The absolute value of coefficient and

local p -value illustrate the different influence of the single mechanism in each spatial unit. These results reveal three findings: First, The local models apparently have better performances than global approaches in both years (Table 4.5). The larger R-squares of the local models (0.88 and 0.8) reflect GWR models can better reveal the changes of economic development than global models (0.57 and 0.68). Two other diagnostic statistics, AICc and sum of residual squares (SRS), also provide strong evidence since

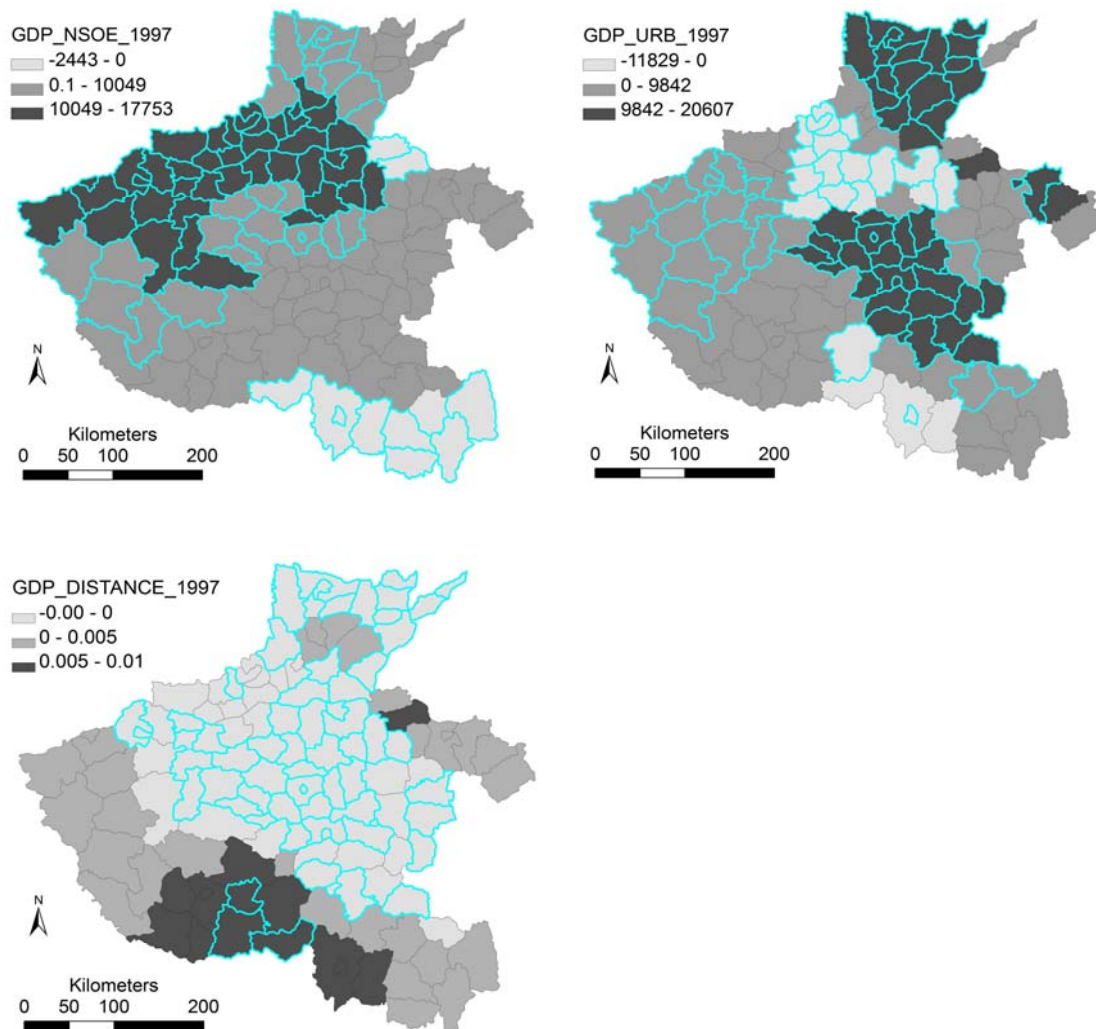


Figure 4. 4 Spatial variations of mechanisms in 1997 for Model One (Coefficients are only significant in highlighted units).

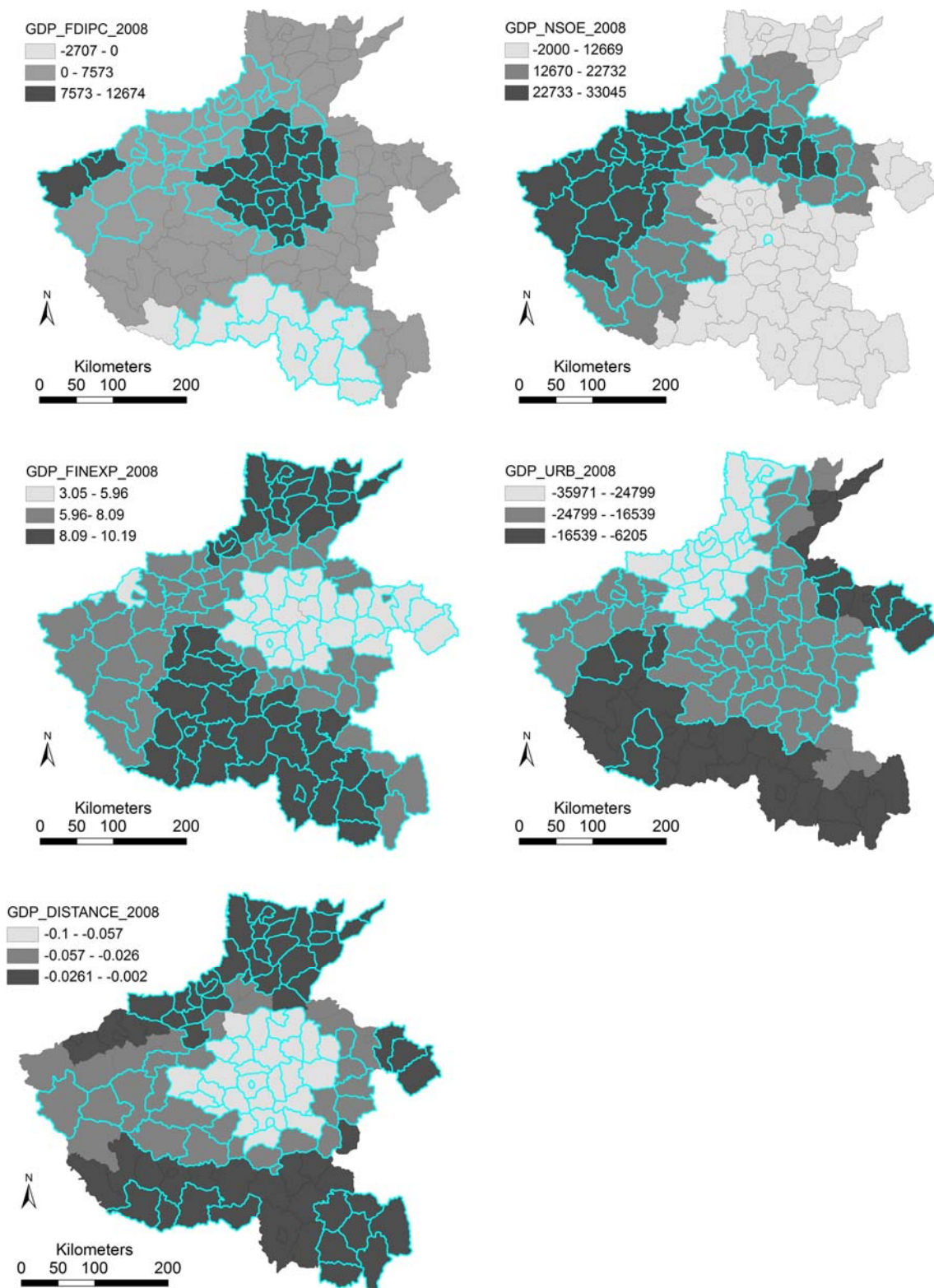


Figure 4. 5 Spatial variations of mechanisms in 2008 for Model One (Coefficients are only significant in highlighted units)

smaller values of AICc and SRS indicate an improvement in goodness of fit of the model. These indicators demonstrate that Henan's regional economic inequality is greatly influenced by spatial nonstationarity in development mechanisms.

Second, the effects of multimechanisms on local economic growth were highly influenced by the local initial conditions and expressed complex spatial variations in 1997 (Fig. 4.4). NONSOE, reflecting marketization, was significant positively in the northern half of Henan, and negatively in nine southern counties and districts (eight of them in Xinyang). The marketization process highly contributed to the local growth of the northern area where the traditional and emerging industrial bases are located, for example, Zhengzhou, Luoyang, Jiaozuo, and Jiyuan. The development of non-state-owned enterprises (hereafter NSOE) apparently accelerated economic prosperity when state-owned enterprises (hereafter SOE) were in difficulty after the marketization reform in 1992. However, for southern agriculture-oriented counties, SOE was still the advantageous part of the local economy compared to the dominant agriculture sector. In Xinyang, the first industry (agriculture) accounted for 41% of GDP in 1997, much higher than that (6%-15%) in four aforementioned industrial Cities (Henan Statistic Year Book, 1998). The map for urbanization shows one negative cluster around Zhengzhou City and three positive ones in northwest, northeast, and central areas. Urbanization was negative associated to the economy in Zhengzhou, Jiaozuo, and a few counties in Kaifeng and Xinxiang, although the rural area lagged far behind the urban in most areas of Henan. Within the negative cluster, some counties generated more per capita wealth than districts by benefiting local advantages, for instance, mineral resources in Gongyi and Xinmi, tourism in Xiuwu and Dengfeng, and the air harbor of Xinzheng. The capital effect

(DISTANCE) was unable to cover the entire province but only the central and northeastern areas close to Zhengzhou City.

Third, Henan's economic transitions have been experiencing fundamental changes and provincial development strategies played a key role reshaping the regional inequality pattern in 2008 (Fig. 4.5). FDI and FIXEXP indicate the forces of globalization and decentralization. They became significant in the global model, revealing that the local economic development became more dependent on the investment from both local government (FINEXP) and outside sources (FDI). FDI formed a large positive cluster, including the core area and a few other counties. Globalization was an active driving force in the core area which attracted 31.5 billion USD, 78% of the total FDI of Henan Province in 2008 (Henan Statistic Year Book, 2009). Increasing local investment is another momentum pushing the entire province's development. The larger coefficient values of FINEXP in the periphery area reflect that the periphery area relied more on the local government investment than the core area. URB changed to a completely negative factor when the rapid urbanization process narrowed the urban-rural gap and slowed down urban economic growth to some extent. This trend mainly emerges in the core area and URB is not significant in the southwestern, southern, and eastern agricultural areas. The capital (Zhengzhou City) expressed much stronger and broader driven effect compared to that in 1997, which radiated from the core area to the border counties. The growth pole has generated considerable power determining the trend of provincial development. Marketization (NONSOE) showed a similar cluster in the northern area to that 12 years ago, indicating that promoting non-state-owned enterprises is still an effective way of promoting economic growth.

Health Care Inequality in Henan Province

The previous section discusses the variation of economic inequality; this section explores the social unevenness in Henan Province during the reform era. The results of a survey indicate that the health care is the leading concern of Chinese people (Hu et al., 2008; Li & Wei, 2010b). As an appendage of the economic system, China's health care system has been fundamentally influenced by the restructuring of the economic system and has transformed from a centrally planned to a market-based one (Ma et al., 2008; Xiong, 2009). Henan's health care sector has also been changing with the advent of health care reform in 1985, the establishment of the urban health insurance system in 1998, the implementation of the New Cooperative Medical System in 2003, as well as the new provincial development strategy. The rapid economic growth has provided strong financial support for remarkable development of medical care in Henan Province. By the end of 2009, Henan had 435 thousand health professionals and 302 thousand hospital beds, and the assets of the health care sector reached 58.5 billion Yuan (Wang & Chen, 2010). By 2007, 157 counties had implemented the New Cooperative Medical System, covering 92.06% rural residents (Wang & Chen, 2010). However, health care is still one of the most difficult problems in people's daily life due to the extremely high medical costs and the unbalanced distributions of health care level.

Spatial-temporal variation of health care equality

Fig. 4.6 and Table 4.6 present the results of CVs of hospital beds per 10,000 persons at prefecture- and county-level administrative units from 1993 to 2008. The prefecture-level unevenness increased while the county-level inequalities all decreased.

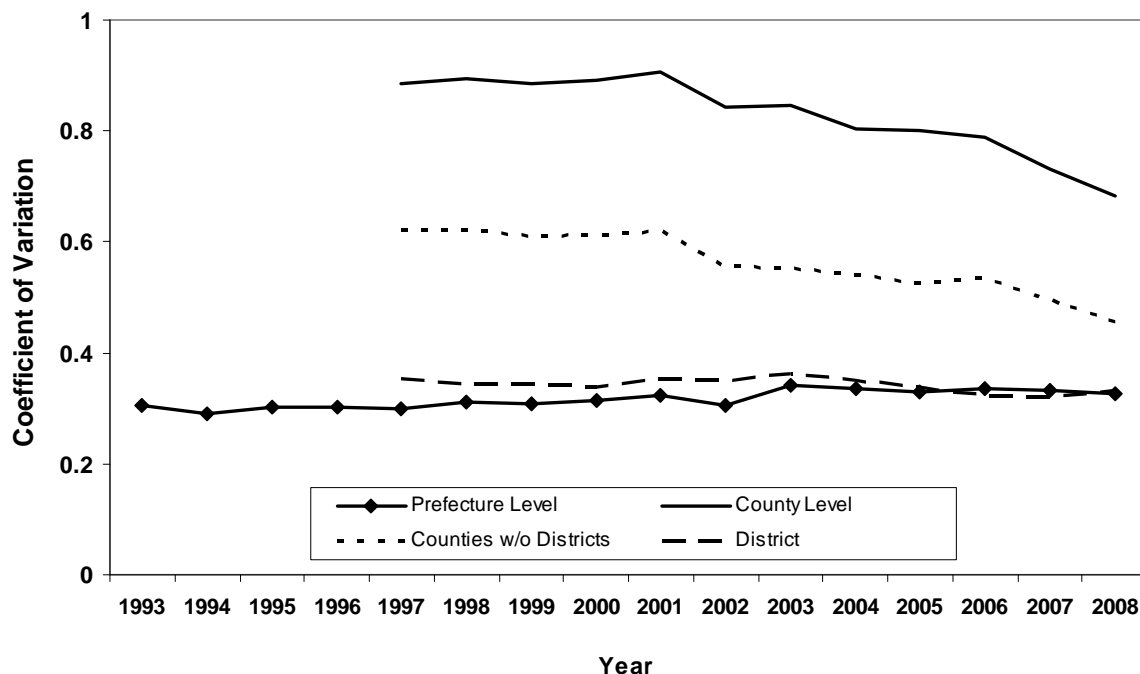


Figure 4. 6 Changes in the coefficient of variations of health care level in Henan Province.

Table 4. 6 Coefficient of variation (CV) of the health care quantity of Henan Province.

Units	1993	1997	2000	2005	2008
Prefecture cities (18)	0.3	0.30	0.32	0.33	0.33
All county-level administrative units (159)	N/A	0.89	0.89	0.80	0.68
Counties w/o Districts (108)	N/A	0.62	0.61	0.53	0.46
Districts (51)	N/A	0.35	0.34	0.34	0.33

The prefecture-level line remains flat all the time, changing from 0.3 in 1997 to 0.33 in 2008. CVs of all county-level administrative units and of counties show similar inequality trajectories, keeping flat from 1997 to 2001 and declining significantly since then. The differences in health care facilities among districts did not change much before 2003 but went down slightly after that. Hotspot analysis reveals the spatial patterns of Henan's health care inequalities in 1997 and 2008 (Fig. 4.7). Different from economic

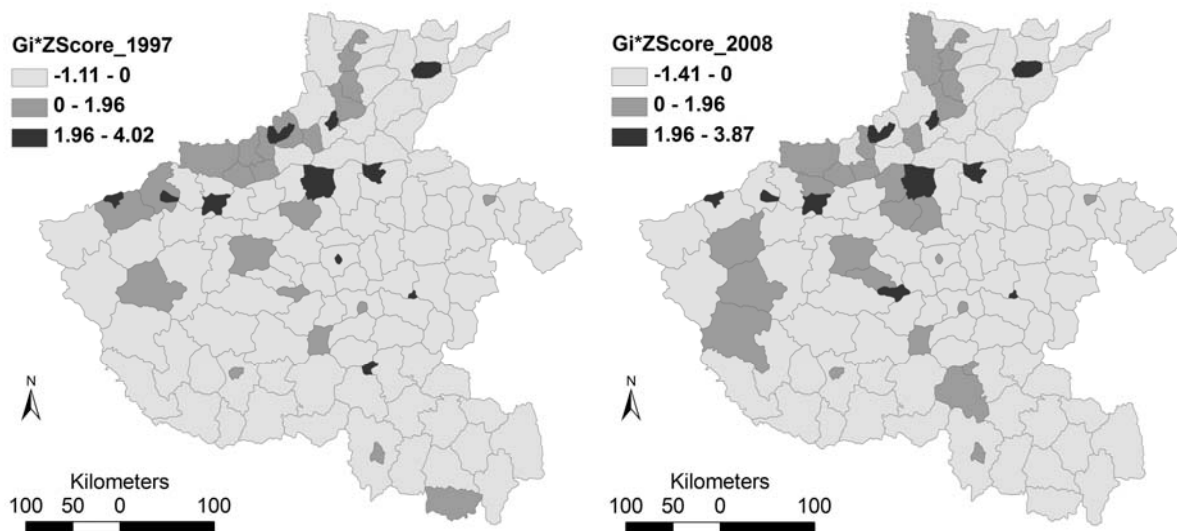


Figure 4. 7 Hotspot analysis of hospital beds of Henan Province in 1997 and 2008.

inequalities, the spatial distributions of health care did not vary largely with time or form large spatial concentration. Instead, the hotspots with high health care level mostly scatter in the districts of the core area.

These statistical results reflect three findings of Henan's health care inequality. First, both urban-rural and rural-rural unevenness are very significant although they have been largely reduced with the implementation of New Cooperative Medical System and urbanization process. CVs among all county-level administrative units decreased from 0.89 in 1997 to 0.68 in 2008; and those of counties without districts also declined from 0.62 to 0.46 (Table 4.6). The number of hospital beds per 10,000 persons in districts was over three times that in counties, reflecting that health care facilities are highly concentrated in the urban area (Table 4.7). With the urbanization process, more and more rural immigrants share social resources with urban residents and therefore reduce per

Table 4. 7 The urban-rural and core-periphery gaps of health care quantity in Henan Province.

Region	Area	1997	2000	2005	2008
All	All	20.3	21.0	21.5	25.7
	District	53.5	58.2	54.3	57.5
	County	14.0	13.9	14.3	18.0
Core	All	28.5	28.3	29.2	34.5
	District	71.0	73.3	67.6	71.7
	County	16.9	16.2	17.1	21.6
Periphery	All	15.0	16.2	16.4	19.7
	District	34.1	41.0	39.4	41.4
	County	12.3	12.6	12.6	15.8

capita health care resources in the urban area. At the same time, rural health care level has been improved through the New Cooperative Medical System. From 2003 to 2007, the province raised 5.34 billion Yuan for this program, over 20% of which had been applied to build and enhance hospitals and train health professionals in the rural area across the province (Wang & Chen, 2010). These policies have effectively alleviated the urban-rural gap in health care level. The number of hospital beds per 10,000 persons in districts decreased from 58.2 in 2000 to 57.5 in 2008, whereas that of counties increased from 13.9 to 18.

Second, core-periphery difference is also prominent. The number of hospital beds per 10,000 persons in the core area was about twice that in the periphery area (Table 4.7). Literature has demonstrated the effect of economic inequality on health care distribution (Li & Wei, 2010b). The local economy in the core area apparently has provided strong support for developing the health care sector. Besides the economic factor, hierarchy of public hospitals also contributes to the huge core-periphery gap. China's health care sector is still dominated by public hospitals, which has been ranked at different levels like

other administrative institutions. Provincial and prefecture-level hospitals have more medical facilities and skilled professionals, while county and township hospitals are usually poorly equipped. The most advanced provincial-level hospitals all agglomerate in the capital. In 2008, Zhengzhou City had 27,396 hospital beds, accounting for over 10% of the total in Henan Province (Henan Statistic Year Book, 2009). In addition, the core area contains several traditional industrial cities, for example, Zhengzhou, Luoyang, Jiyuan, and Jiaozuo where a series of large-scale state-owned enterprises and supporting facilities were established including hospitals during Mao's era. These medical facilities are still functioning despite the decline of SOEs. Consistent to economic development, the core-periphery health care inequality has not been decreased over time because of Henan's polarized development strategy.

Third, we found a similarly changing trajectory from the health care quality perspective, indicated by doctors per 10,000 persons. Both core-periphery and urban-rural gaps have been reduced. Doctors per 10,000 persons declined from 15 to 14.5 in the core area while they increased from 8.9 to 9.2 in the peripheral area. The number dropped from 31.9 to 26.4 in the urban area, but rose from 7.4 to 7.8 in the rural area. Due to these two changes, the disparities of health care quality have been equalized at both prefecture- and county-levels (Table 4.8). However, the health care quality has not gained significant improvement (Table 4.9) like health care facilities. From 1997 to 2008, doctors per 10,000 persons increased slightly from 11.5 to 12.7 in the entire province and even decreased from 31.9 to 26.4 in the urban area. Despite the declining inequality in health care quality, these results reveal another problem of Henan's, and even China's, healthcare system. The input for enhancing health care quality is very limited compared

Table 4. 8 Coefficient of variation (CV) of health care quality of Henan Province.

Units	1997	2000	2005	2008
Prefecture cities (18)	0.55	0.54	0.55	0.54
All county-level administrative units (159)	0.91	0.87	0.73	0.67
Counties w/o Districts (108)	0.52	0.48	0.45	0.42
Districts (51)	0.39	0.33	0.31	0.31

Table 4. 9 The urban-rural and core-periphery gaps of health care quality in Henan Province.

Region	Area	1997	2000	2005	2008
All	All	11.54	11.8	11.4	12.7
	District	31.9	33.7	27.5	26.4
	County	7.4	7.7	7.6	7.8
Core	All	15.0	15.1	14.2	14.5
	District	55.5	56.6	44.6	42.9
	County	8.2	8.4	8.3	8.7
Periphery	All	8.9	9.3	9.0	9.2
	District	21.6	24.3	19.9	19.8
	County	6.8	7.2	7.2	7.3

to that for the medical facilities. The hospital beds in Henan increased from 189 to 268 thousand; while the doctors only varied from 106.7 to 119.3 thousand during 1997 to 2008 (Henan Statistic Year Books). In 2005 the total number of Doctors in China was 1.94 million, 46.6 thousand less than 1997, while the medical expenditure increased 1.7 times at the same period (Zhou, 2007). Namely, the number of doctors reduced when the medical demand rapidly rose. The shortage of doctors, in particular primary care doctors, has been one of the major reasons causing difficult access to medical care.

Nonetheless, a more startling picture has been hidden behind the measurements indicating the decreasing inequalities in health care quantity and quality. The distribution

of Grade-A hospitals (*Sanjia Yiyuan*) are significantly agglomerated (Fig. 4.8). According to *Hospital Grading and Management Standard*, currently 35 hospitals are ranked as Grade-A in Henan, the highest-level hospitals in terms of medical service and management, medical quality and safety, education and research capacity, etc. Among them, 30 are concentrated in the core area, 34 are located in the urban districts, and 12 are clustered in the urban capital (districts of Zhengzhou). Therefore, the most

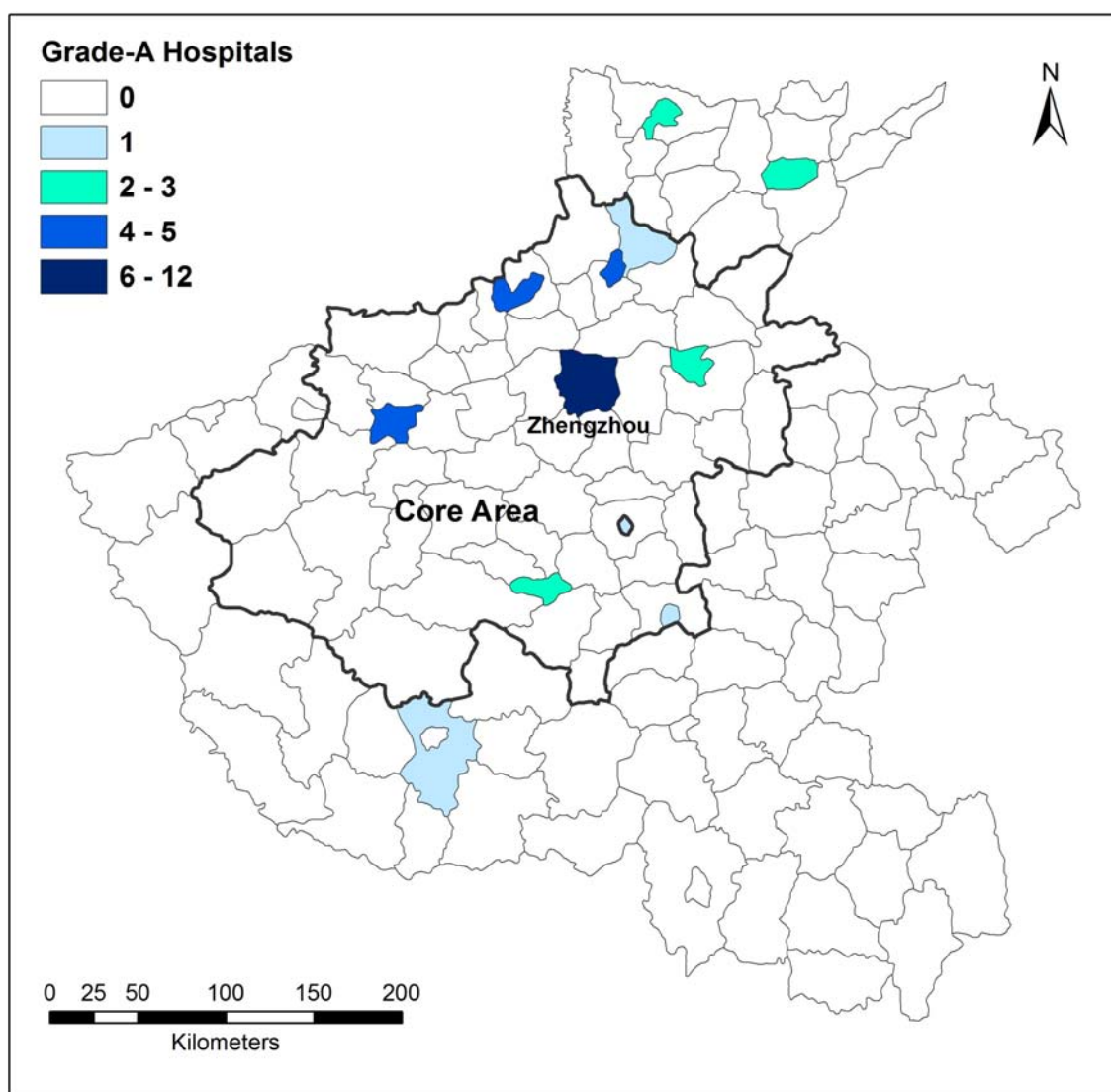


Figure 4. 8 Spatial distribution of Grade-A hospitals in Henan Provinces.

advanced medical care has not been spatially balanced, although the core-periphery and urban-rural inequalities of the hospital beds and doctors have been reduced with the health care reforms.

Health care inequality and economic transitions

The results of Model Two, including global and local regressions with 1997 and 2008 datasets, are reported in Tables 4.10 and 4.11. For the global OLS models, 85% and 81% of health care variation can be explained by five independent variables. GDPPC and URB are significant at 5% level in the 1997 model, and FINEXP, URB, and DISTANCE are significant in the 2008 model. These significant variables are mapped in Figs 4.9 and 4.10. These results reveal three points of the spatial-temporal variation of Henan's health care.

First, the local models of Model Two also show better explanation power than global regressions. The GWR models reflect 94% (R-square = 0.94) and 86% (R-square = 0.89) of health care changes in 1997 and 2008, higher than both OLS models (R-squares: 0.85; 0.81). GWR models generate significantly lower values of AICc and SRS, which also demonstrate the higher fit goodness and accuracy of local models.

Second, the levels of local economy were the determinant factors for shaping health care pattern at the early stage of reform (Fig. 4.9). GDPPC, indicating economic development, is significant in about 2/3 of county-level units. It forms a huge positive cluster covering the central, southern, northeastern, and northwestern parts, as well as two small negative clusters in northwestern and northern areas. The health care levels of most spatial units were in accord with the local economy. The influence of URB (urbanization)

Table 4. 10. Global OLS regression results for Model Two.

1997				2008			
Dependent variable	Health care			Dependent variable	Health care		
Independent variable	Coefficient	P-value	VIF	Independent variable	Coefficient	P-value	VIF
Intercept	2.79	0.23	N/A	Intercept	7.88	< 0.01	N/A
FDIPC	-3.03	0.41	2.90	FDIPC	4.41	0.04	2.01
NONSOE	11.49	0.12	1.28	NONSOE	-3.63	0.51	1.29
FINEXP	0.00	0.17	2.04	FINEXP	0.01	< 0.001	4.39
URBANIZATION	78.64	< 0.001	5.27	URBANIZATION	31.45	< 0.001	2.92
DISTANCE	0.00	0.13	1.22	DISTANCE	0.00	< 0.01	1.24
GDPPC	0.00	0.05	2.32	GDPPC	0.00	0.27	3.12

Table 4. 11 Comparison between OLS and GWR models (Model Two).

	1997		2008	
	OLS	GWR	OLS	GWR
Multiple R-squared	0.85	0.94	0.81	0.89
Adjusted R-squared	0.84	0.92	0.80	0.86
AIC	905	856	909	883
Residual Squares	7,191	2,855	7,409	4,302

expresses more complex spatial variations. Urbanization is positively associated with health care level in the entire northeastern, eastern, and southern areas. Similar to the wealth agglomeration in urban area, the urban concentration was also the dominant pattern of Henan's health care distribution. However, an opposite trend showed in the central core area, where counties and districts with higher degrees of urbanization had lower health care levels instead. Comparing the pattern of URB coefficient in Fig. 4.4 and Fig. 4.8, we found that the negative clusters in the core area are partially overlapped in two maps. In this area, urbanization was negatively correlated to both local economy and health care level. Based on the literature and above analysis, we believe that the

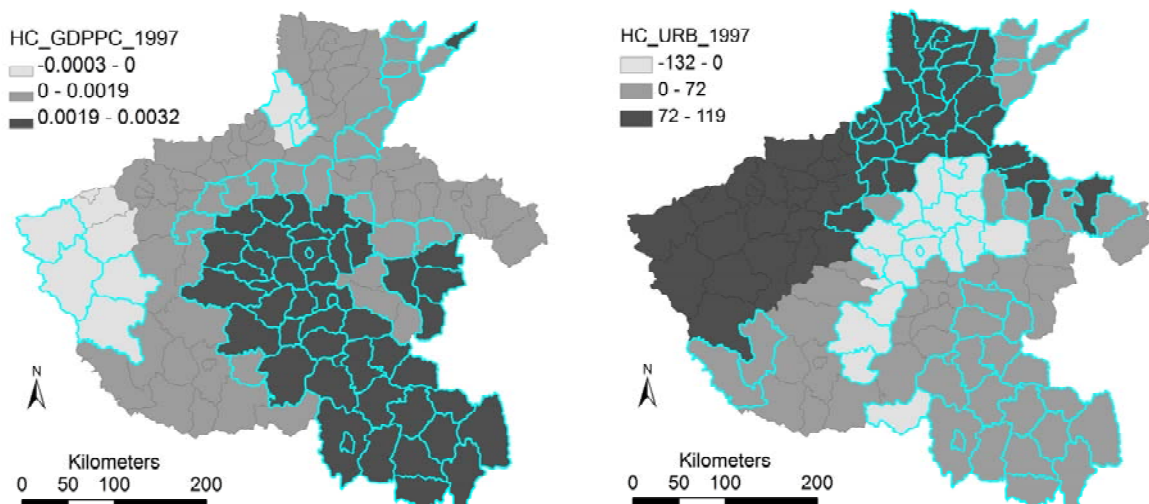


Figure 4. 9 Spatial variations of mechanisms in 1997 for Model Two (Coefficients are only significant in highlighted units).

decisive factor of health care level was not urbanization but local economic development.

Third, government intervention has had a certain effect on the health care sector although health care inequality has not been fundamentally reduced (Fig. 4.9). Local economic development (GDPPC) was not significant to health care level any more in 2008. Instead, per capita local budget expenditure (FINEXP) became the determinant force, since decentralization was the most important structural change in the health care market following the economic reforms (Akin et al., 2005). Except in the northwest area, FINEXP contributed to elevate health care level in the rest of the province and had stronger influence in the eastern half of Henan. Urbanization (URB) still showed dual effects across the space, whereas its spatial pattern completely changed. In the western side, the places with higher degrees of urbanization had better medical care; while an opposite trend showed in a long stripe of the eastern part where local budget expenditure happened to play a more substantial role. This eastern area is mainly composed of less

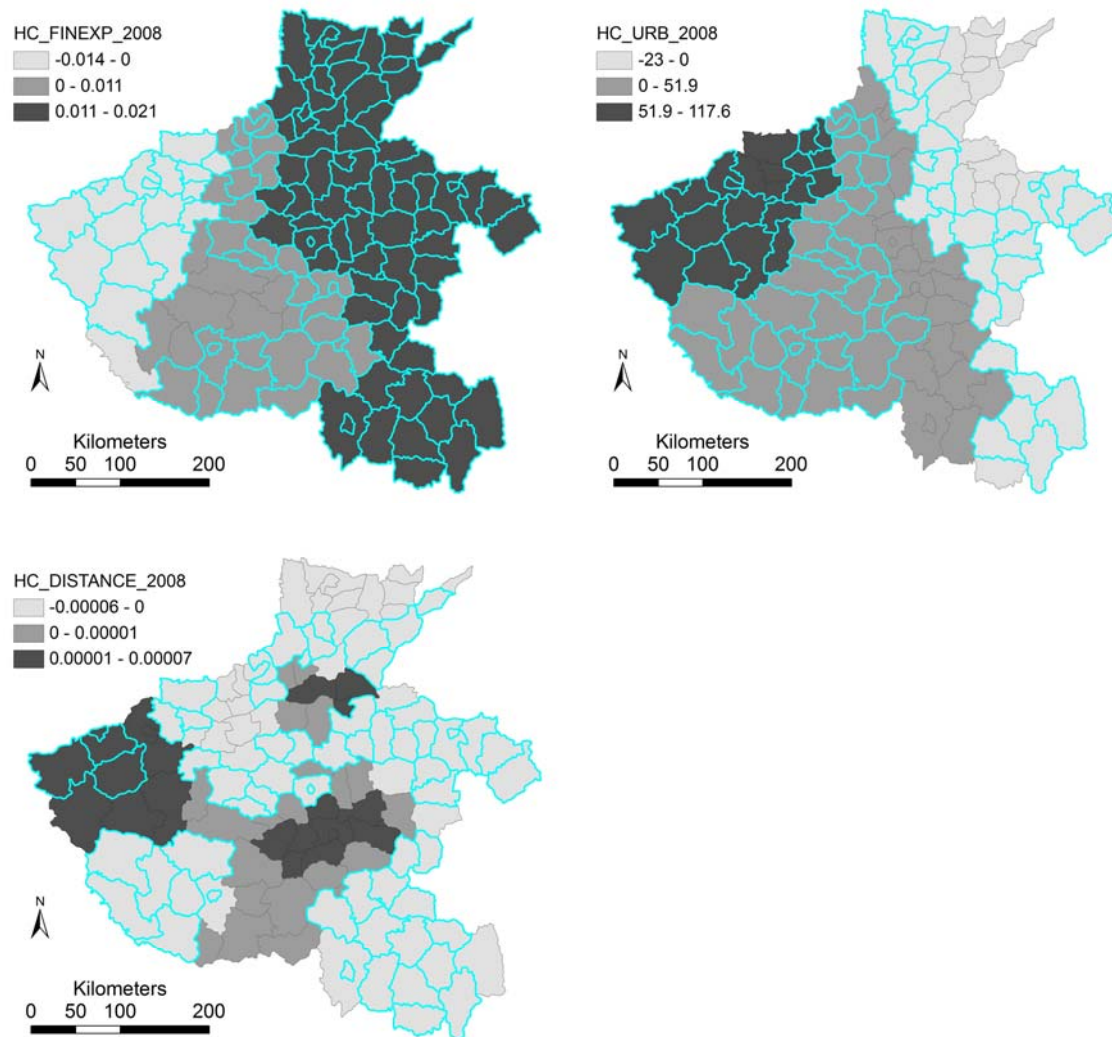


Figure 4. 10 Spatial variations of mechanisms in 2008 for Model Two (Coefficients are only significant in highlighted units).

developed agricultural counties under Xinyang, Zhoukou, Zhumadian, Shangqiu, and Kaifeng. The investment from the New Cooperative Medical System greatly helped to improve the health care level in this area. The capital effect (DISTANCE) on health care distribution was not as strong as that on economic inequality. Distance to Zhengzhou mattered in less than half of the county-level units. Among them, the counties and districts nearby the capital have a higher health care level.

Conclusion

This paper enriches the literature by investigating the spatial-temporal variations and underlying mechanisms of both economic and social inequalities in Henan Province, attempting to understand China's regional development with the case study on a central agricultural province instead of often studied eastern/coastal provinces. It examines economic unevenness at prefecture- and county-levels from 1993 to 2008 and finds that the development patterns varied with the implementation of a polarized development strategy and urbanization progress. The strategy of "the rise of Zhongyuan Economic Zone" has further enlarged the core-periphery gap and caused wealth concentration in the core area around the capital, Zhengzhou. In contrast, urbanization has significantly narrowed the urban-rural difference in the last decade, although the disparity is still phenomenal. Generally, similar to the coastal province, the core-periphery pattern dominates the overall trend of economic inequality. However, Henan province has only a solitary growth pole surrounding the capital. The second center, Luoyang, has not yet formed the second cluster with its nearby counties. Differently, the coastal provinces usually express a multicenter pattern. For example, three concentrations exist in the coastal province, Zhejiang, including the tradition capital cluster (Hangzhou-Shaoxing-Ningbo), central cluster, and Wenzhou-Taizhou concentration benefiting from private enterprises (Wei & Ye, 2009). Depending on industry agglomeration and private enterprise prosperity, the two newly emerging centers have grown as strong competitors competing with the traditional one.

Our research reveals that the effect of multimechanism on Henan Province shows distinctive local characteristics. The spatial nonstationarity in development mechanisms

plays an important role and the influence of each mechanism varies across space and time. Marketization (NONSOE) only had effect in such northern industrial cities as Zhengzhou, Luoyang, Jiaozuo, and Jiyuan but had little influence in the southern agricultural area. Rapid urbanization process (URB) has decreased rural-urban economic inequality and at the same time generated some negative impact on urban economic growth, especially in the core area. Decentralization (FINEXP) and globalization (FDI) became important mechanisms accelerating the local economy in 2008. The periphery area relied more on local investment (FINEXP) because of the lack of FDI; while the core area easily attracts both internal and external investments. The radiation effect of the capital has been greatly expanded, capable of covering the entire province. Multimechanisms have been guided by the provincial development strategy and effectively strengthened the power of growth poles. In contrast, in the coastal provinces, the economic development pattern is largely determined by market effect instead of the administrative intervention, for example, TVE-centered Sunan Model in Jiangsu (Wei, 2002) and FDI-driven Pearl River Delta Model in Guangdong (Lu & Wei, 2007).

This study also investigates the provincial health care disparity as one of the most important consequences of economic inequality. The distribution of health care has been highly influenced by health reforms and economic transition. The implementation of the new Cooperative Medical System has significantly decreased the rural-rural and urban-rural disparities in health care access in Henan, different from the increasing health care inequality within the entire country (Li & Wei, 2010b). Both health care facilities and doctors tended to concentrate in the urban area, especially in the districts of the core area. The urban-rural and core-periphery gaps are still sharp due to economic inequality and

the hierarchical structure of public hospitals. The influence of local economy on health care level has been weakened with the economic transitions. Decentralization and urbanization have been two determinant forces reshaping the spatial pattern of health care inequality. Marketization and globalization have had little effect since the public hospitals dominate the health care sector. We found that these mechanisms worked differently across the space because of local initial conditions and provincial development strategies, which makes a step forward compared to the existing literature (e.g., Li & Wei, 2010b; Zhao, 2006).

These findings have policy implications. The central and local governments have made efforts for reducing regional and provincial economic and social inequalities and obtained some effects. However, the rising core-periphery disparities within Henan province reflect that the governments also need to balance the capital and resources at finer scale. In addition, rapid urbanization has created a series of social problems. For example, the urbanized peasants losing their land have not obtained equal accesses to health care, education and employment, therefore causing a rising crime rate, polarization within the urban area, and etc. In addition, the shortage of doctors has become a serious issue, which may reflect more profound problems of China's healthcare system.

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CHAPTER 5

DISCUSSION AND CONCLUSION

With the dramatic economic growth in China in the last three decades, China's regional development has attracted more and more attention from scholars and policy makers. Numerous studies appear in this field for better understanding the pattern, process, and driving forces of China's regional inequality. However, a few study areas still warrant further investigation.

First, due to the limitation of research methods, little is known about the relative importance of the contributing mechanisms of the rising inequality in China, despite the fact that there has been extensive research discussing the causes (Li & Wei, 2010a; Wei, 2007). China's development policies and strategies have distinctive hierarchical characteristics, which have fundamentally influenced the transitions of the country as well as the process of socioeconomic development. Studies on development mechanisms follow the traditional single-level regression models, which treat the units of analysis as independent observations and fail to recognize hierarchical structures. From the methodological aspect, the single-level model leads to an overestimation of statistical significance because of overstatement of standard errors of regression coefficients. From a policy perspective, the spatial-temporal hierarchy of regional inequality has not been

deeply examined, which might hide some important features during China's development process.

Second, the research on the social consequences of the rising economic inequality is lacking (Wan & Zhang, 2006). China's reform and transition have dramatically accelerated the economic growth and also enlarged regional disparities. People are increasingly dissatisfied about wealth distribution as well as well-being unevenness. The literature has overwhelmingly emphasized regional economic inequality but neglected the social inequality as both a cause and a consequence of economic disparity (Cao, 2008; Li & Wei, 2010b), for example, health and health care unevenness. The inequality of health care has intensified, which merits more attention from geographers (Wei, 2007). There has been extensive research on unequal distribution of health care (Cai, 2009; Liu et al., 2008); however, little research focuses on this issue from a geographical angle and explores the causal linkage between economic inequality, health care, and health outcome.

Third, more recently, the literature tends to analyze finer-scale inequalities (Wan & Zhang, 2006), while the central and other interior provinces have been rarely studied, and a summary of their development characteristics is lacking. Most finer-scale research focuses on the coastal/eastern region, and some recent studies start to pay attention to the western region. The major reason is that these two regions are favored by China's national development strategies, and therefore they have displayed more significant variation during the reform period. As the cradle of Chinese civilization and culture, the central provinces have been rarely examined in relation to the development processes and regional inequality. It might provide a different view for understanding China's regional

socioeconomic development through studying a central agriculture-oriented province at finer-scale.

This research intends to make up for these inadequacies by providing a spatial-temporal investigation on China's regional inequality under the economic transition within a GIS and spatial statistics framework. Three key findings can be summarized from the analysis of the above chapters.

First, the new development strategies for reducing regional inequality have not achieved the expected results in that the spatial concentration of regional socioeconomic development has further increased. As one consequence of economic inequality, the regional disparity in health displayed some similar characteristics. Both economic and health inequalities are sensitive to geographical scales, and the finer-scale unevenness is larger. The results indicate that the interprovincial inequalities in economic development and health care level declined in the reform era; however, the spatial agglomeration of wealth and medical care well-being have both been intensified. For the economic development, the eastern/coastal region has accounted for a higher percentage of the total GDP than thirty years ago. For health care level, a north-south segmentation has gradually formed and the northern area apparently is able to offer higher provisions to the residents compared to the southern area. The low cluster of health outcome moves from the western to the central region, while the spatial agglomeration is still significant. Municipality effect is a crucial factor for explaining the varying trends. The multiscale economic inequalities are influenced greatly by the four municipalities. The interprovincial gap has been narrowed because of the reduced disparities between the coastal provinces and the municipalities, while the interregional inequality has been

increasing due to the fact that the three richest municipalities (Beijing, Shanghai, and Tianjin) are all located in the eastern/coastal region. Without the municipalities, both interprovincial and interregional economic inequalities decline greatly. As mentioned in Chapter 3, the municipalities have also played an important role in shaping the spatial patterns of health care inequality, since their contributions to global spatial autocorrelation have changed significantly after the health reform.

Second, the application of the multilevel modeling makes the multimechanisms framework more effective to explain regional socioeconomic inequalities in China (Li & Wei, 2010a; Li & Wei, 2010b). The multimechanisms include the state, local agent, and global forces (Wei, 2000) and represent “from above,” “from below,” and “from outside” forces of development (Wei & Fan, 2000, p. 466). Due to the varying development strategies with time, the influence of each mechanism has been shifting in the last three decades which has changed the trajectory of China’s regional socioeconomic development. At the early stage of the economic reform, decentralization power was the leading force which mainly accelerated the economy of the eastern region. Marketization became the most import mechanism in the 1990s and globalization was the dominant direction after 2000. The spatial hierarchy of the multimechanisms also has significant effect on health and health care inequality. Decentralization and urbanization have been the prominent factors of determining spatial patterns of health and health care, while globalization and marketization have had relatively weak influence since state-owned enterprises still dominate China’s health care sector. The results of multilevel modeling also reveal the role of health care in explaining the causal linkage between economic inequality and health outcome, although most Western scholars consider health care to be

a less important factor causing socioeconomic inequalities in health (Robert & House, 2000).

Third, this research detects the core-periphery pattern of regional development through the finer-scale investigation on the central agriculture-oriented province, Henan Province. China's societal polarization of development can be interpreted by coastal-inland and urban-rural disparities (Cao, 2010; Zhang & Kanbur, 2005). The case study on Henan Province emphasizes the urban-rural disparities within the core-periphery theoretical framework, which offers a complementary examination of China's regional development. The analysis illustrates that the huge core-periphery and rural-urban gaps have been existing in both economic development and health care level since 1997. The wealth, medical care facility, and doctors are still highly concentrated in the urban core area, although the intervening strategies implemented by the provincial government have generated significant effects on Henan's socioeconomic inequalities. The polarized strategy of "the rise of Zhongyuan Economic Zone" has enlarged the regional differences of economy and health care level and strengthened the power of the growth pole (the capital), while the rapid urbanization process has decreased the socioeconomic inequalities as a large number of rural residents moved to the urban area. As pointed out by many scholars that there exists significant heterogeneous spatial structure in China's development mechanisms (e.g., Wei & Ye, 2009; Yu, 2006), this study uses geographically weighted regression to further explore the spatial nonstationarity of Henan's regional development. The results demonstrate the distinctive local characteristics of development mechanisms, which worked variously across the space due to different local initial conditions as well as provincial development strategies. The

effect of local economy on health care level has been declining with the economic transitions as well as health reform. Unlike the coastal provinces, Henan's socioeconomic development patterns have been largely determined by the multiple transitions and provincial administrative intervention instead of market effect.

The above findings have both theoretical and policy implications. From a theoretical perspective, the analytical framework of "multiscalar" and "multimechanisms" are combined with such Western theories as the core-periphery model (Krugman & Venables, 1995) and the theoretical pathways for explaining the relationship between economic inequality and health outcome (Lynch et al., 2000; Wilkinson, 1996). The integration of Western theories and China's development mechanisms not only improves the systematic theoretical analysis on China's regional socioeconomic inequalities, but also makes the Western theories applicable to explain China's development. Neither the convergence nor divergence school is capable of capturing the process of China's regional development since each school only emphasizes free mobility of capital or government intervention. China's regional socioeconomic inequalities must be explained through the interwoven forces of the state, local agent, and foreign investors (Li & Wei, 2010a; Wei, 2002). Focusing on the health issue, China and other developing countries are different from the Western industrial countries and characterized by large regional inequality in health care. The Western psychosocial and neo-material mechanisms pay less attention to health care, which is made up of the healthcare-centered framework in this study. The analytical frameworks used in this research can also be adopted to investigate those developing countries which have been experiencing socioeconomic transitions.

From a policy perspective, the analysis illustrates a series of issues challenging China's policy makers. The new strategies for reducing regional inequality cover so many provinces that they cannot gain the expected effects for boosting the development in these areas. The central government may select a few cities as growth poles in the central and western regions in the near future, and then the radiation effects would gradually accelerate the growth in the entire interior area in the long term. The decline of the central region has become a new issue because China's major development strategies focus on the eastern and western regions. The policy makers need to pay more attention to the central region so as to improve the well-being of the 1/3 of the Chinese population living there. The finer-scale investigation on Henan Province reveals the contradiction between the development strategies implemented by the central government and the local coordinated development. The national development strategy has widened the socioeconomic inequalities within a province, and therefore the central and local governments also need to balance the capital and resources at finer scale. In addition, Chinese people's lives have also been plagued by the rapid urbanization, unequal access to health care, the shortage of doctors, and so on.

In addition, this study contributes to the research field methodologically by incorporating GIS, spatial statistics, geographically weighted regression, and the multilevel model into one analytical framework. In particular, the application of the multilevel model identifies the spatial-temporal hierarchy and reveals the relevant importance of multiple mechanisms (Li & Wei, 2010a).

In summary, this dissertation research documents the patterns of China's regional inequalities in economic development and health care; identifies the spatial-temporal

hierarchy and relative importance of multimechanisms; reveals the relationship between health care, mortality, and economic inequality; and conducts a finer-scale investigation on a central province, Henan Province. This study could be improved through four aspects. (1) The micro-level exploration at community and village levels would offer a different picture of China's socioeconomic inequality. This current research emphasizes the role of macro development strategies on the economic transition, while the investigation at community and village levels would reveal the influences of local policies, initial economic conditions, geographic features, as well as culture and customs. (2) The relationship between economic development and population health might be further explained through the psychological factors as well as micro-level material conditions. This study highlights the macro-level material factors, especially health care level. However, according to the Western theories, the physical health can be affected by both material and psychological factors (Lynch, 2000; Wilkinson, 1996). The macro social cohesion and the psychological stress caused by individual socioeconomic status deserve profound examination in future study. (3) The model performance might be improved by adding some indicators of development mechanisms. For example, the decentralization force can only be reflected to some extent by coastal dummy (CDummy), new policy dummy (NPDummy), and local budget expenditure (FINEXP). Other variables should be introduced in future study, for instance, the ratio of the local budget to the budget allocated by the central government. (4) A new model integrating GWR and multilevel modeling might present new findings of China's regional inequality. Scholars have demonstrated the positive spatial autocorrelation and spatial-temporal hierarchy of China's development (Li & Wei, 2010a; Yu, 2006). These two forces are not

separated but interacted. The integrated multilevel GWR is expected to detect the influences of the interacted spatial autocorrelation and spatial-temporal hierarchy on China's regional development.

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